THE PORT OF NEW YORK AUTHORITY

CREATED BY COMPACT BETWEEN THE STATES OF NEW YORK AND
NEW JERSEY AND RATIFIED BY CONGRESS

FIRST PROGRESS REPORT
ON
KILL VAN KULL BRIDGE
BETWEEN
BAYONNE, N. J.
AND
PORT RICHMOND, STATEN ISLAND, N. Y.

APRIL, 1930

75 WEST STREET, NEW YORK CITY

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THE PORT OF NEW YORK AUTHORITY

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THE PORT OF NEW YORK AUTHORITY

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Architect, Hudson River Bridge and Kill van Kull Bridge

York & Sawyer
Architect, Arthur Kill Bridges

CONSULTANTS

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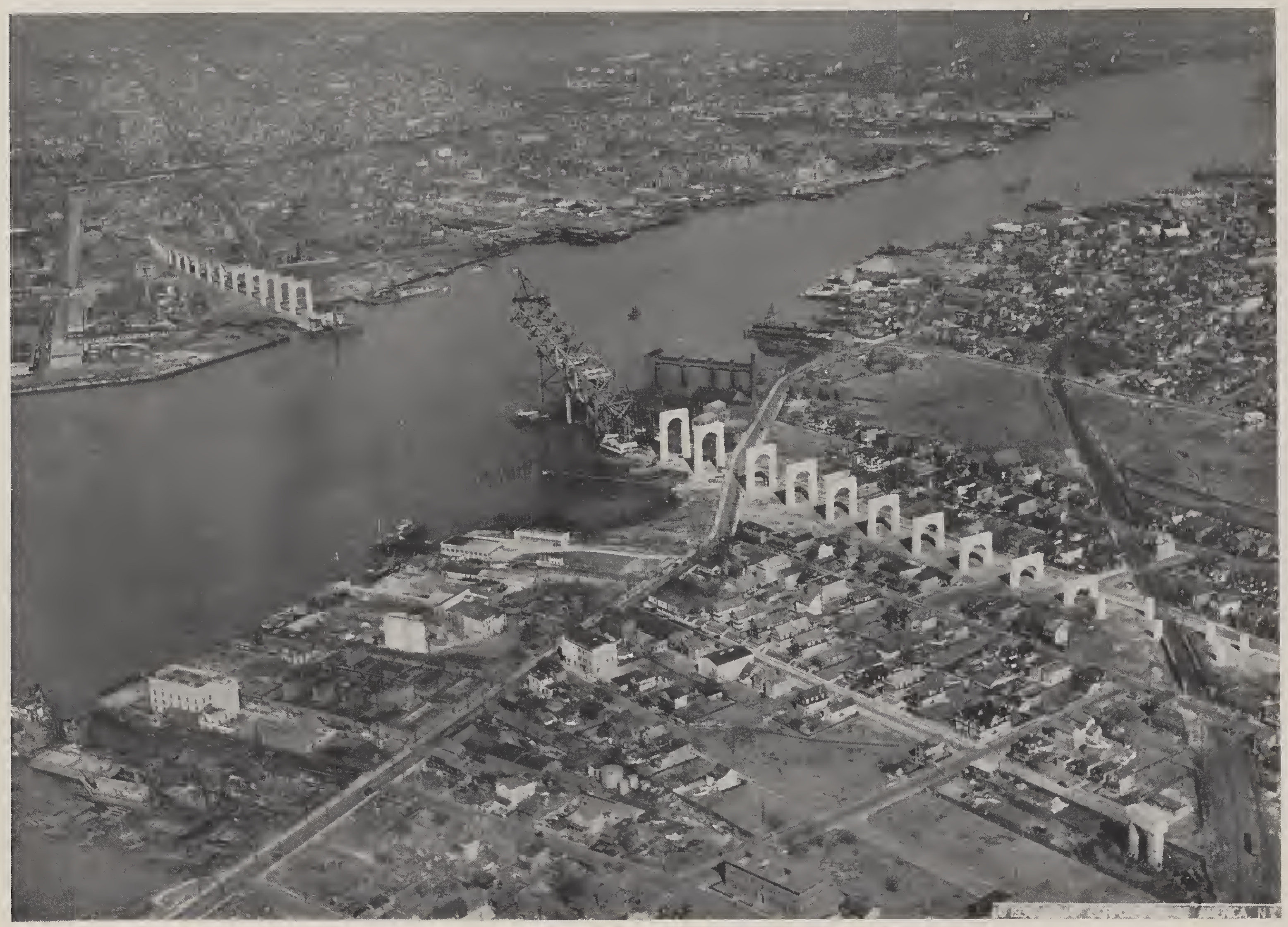


AIR VIEW OF KILL VAN KULL BRIDGE, MARCH 15, 1930

April 15, 1930.

To the Commissioners of The Port of New York Authority.

Gentlemen:

A tentative report on the Kill van Kull Bridge between Bayonne, New Jersey, and Port Richmond, Staten Island, New York, was rendered on February 1, 1927, after preliminary studies, begun in 1926, had been completed.

By November, 1927, preliminary work had progressed sufficiently to enable definite conclusions to be drawn with respect to the economic practicability of the project, and in that month application was made to the War Department for approval of plans.

The financing was effected through an issue of $12,000,000 Port of New York Authority, New York-New Jersey Interstate Bridge Gold Bonds, which were sold on January 5, 1928, and by an appropriation of $2,000,000 by each of the States of New York and New Jersey, making a total of $16,000,000 available for this undertaking.

The $12,000,000 of bonds sold to the public bear interest at the rate of 4%. They were placed on the market at 101, representing a yield of 3.92%, which is the most satisfactory basis on which Port Authority bonds have been sold.

This is to be a toll bridge. The Port Authority bonds are secured by a first lien on the revenues which will be derived from tolls. The moneys advanced to the Port Authority by the two states as an aid in the construction of the bridge will be repaid with interest at the rate of 4%.

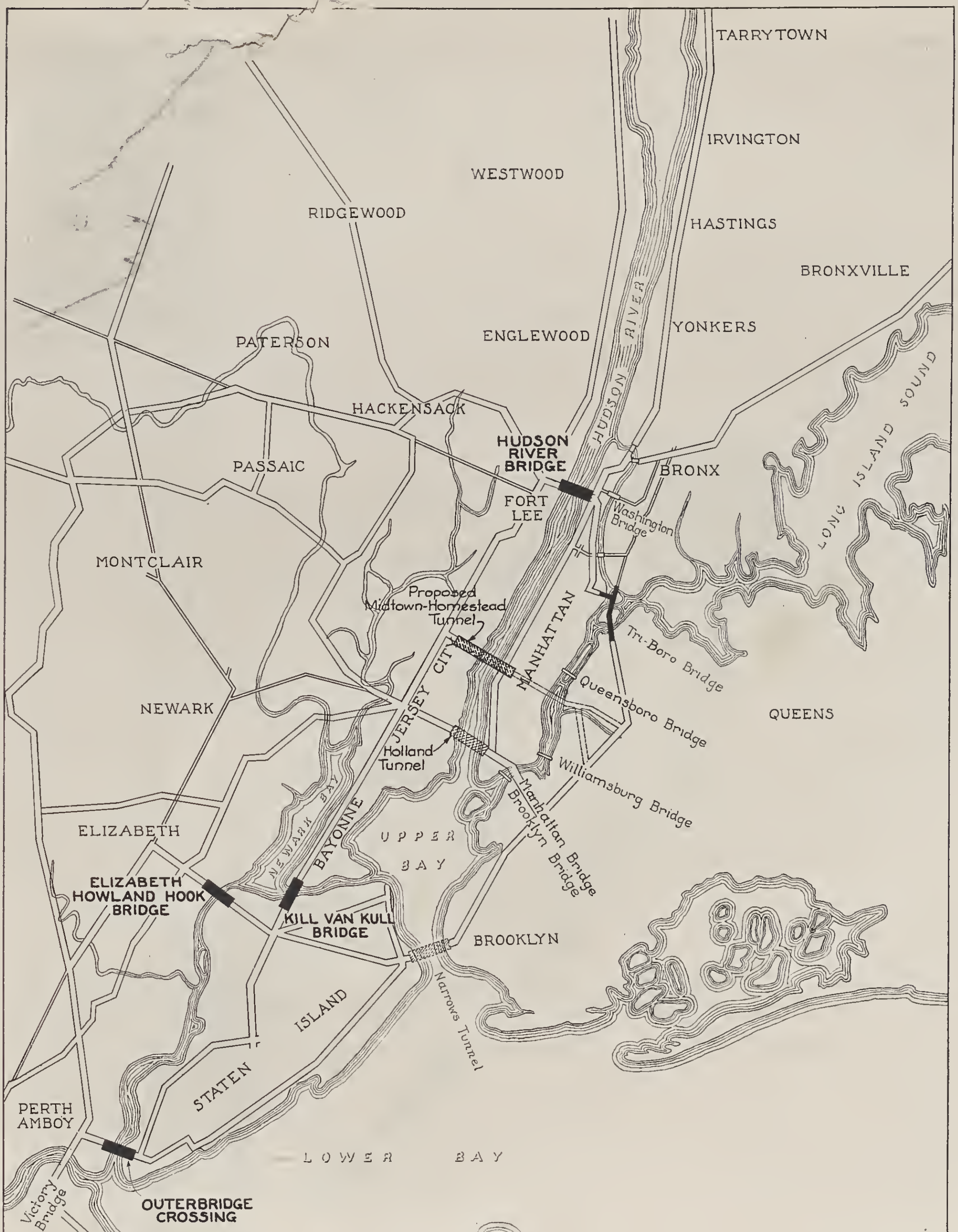
As it was found advisable prior to the sale of the bond issue for this project to anticipate our real estate requirements, a temporary loan of $1,000,000 was obtained for this purpose, and the purchase of property required for the bridge site was well under way before actual construction work was begun. The sum of $2,746,000 has to date been expended for real estate, covering about 98% of the total required; the remaining parcels lie along the outer edge of the right of way and their acquisition has been deferred pending approval of final approach plans.

To date construction contracts have been let to the amount of $6,200,000, representing 56% of the estimated cost of all construction work required to open the bridge to traffic. The remaining contracts, for which sufficient funds are available, will cover completion of main abutments, approaches, deck, lighting, and a few smaller items. The cost is well within estimates.

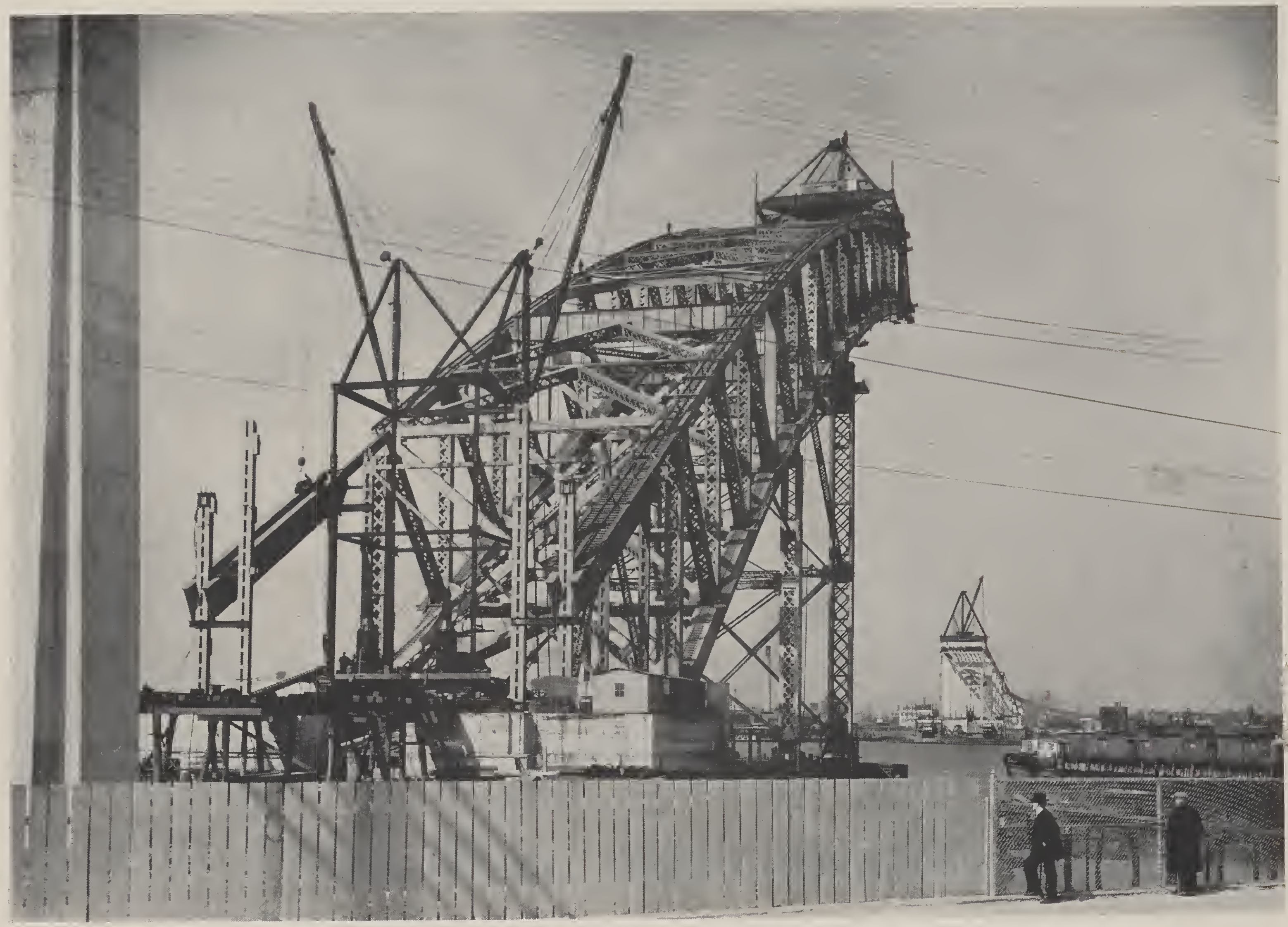
The bridge is expected to be ready for opening to traffic early in 1932.

I respectfully submit herewith the report of the Chief Engineer of Bridges, which sets forth in detail the principal problems involved in the construction of the bridge.

J. E. Ramsey
Chief Executive Officer



THE PORT of NEW YORK AUTHORITY
LOCATION of INTERSTATE LINKS
between
NEW YORK and NEW JERSEY



KILL VAN KULL BRIDGE—ERECTION OF SOUTH ARM OF ARCH COMPLETED—BAYONNE APPROACH IN BACKGROUND—APRIL 1, 1930

KILL VAN KULL BRIDGE

FIRST PROGRESS REPORT

Report

By the Chief Engineer of Bridges

April 1, 1930

Mr. J. E. Ramsey, *Chief Executive Officer*

Dear Sir:

Preliminary engineering studies and surveys for the Kill van Kull Bridge between Bayonne, New Jersey, and Port Richmond, Staten Island, New York, were begun in April, 1926, in accordance with Chapter 97 of the Laws of New Jersey, 1925, and Chapter 279 of the Laws of New York, 1926, which authorized and empowered The Port of New York Authority, in partial effectuation of the Comprehensive Plan for the development of the Port, to construct, operate, maintain and own the proposed bridge, with the necessary approaches.

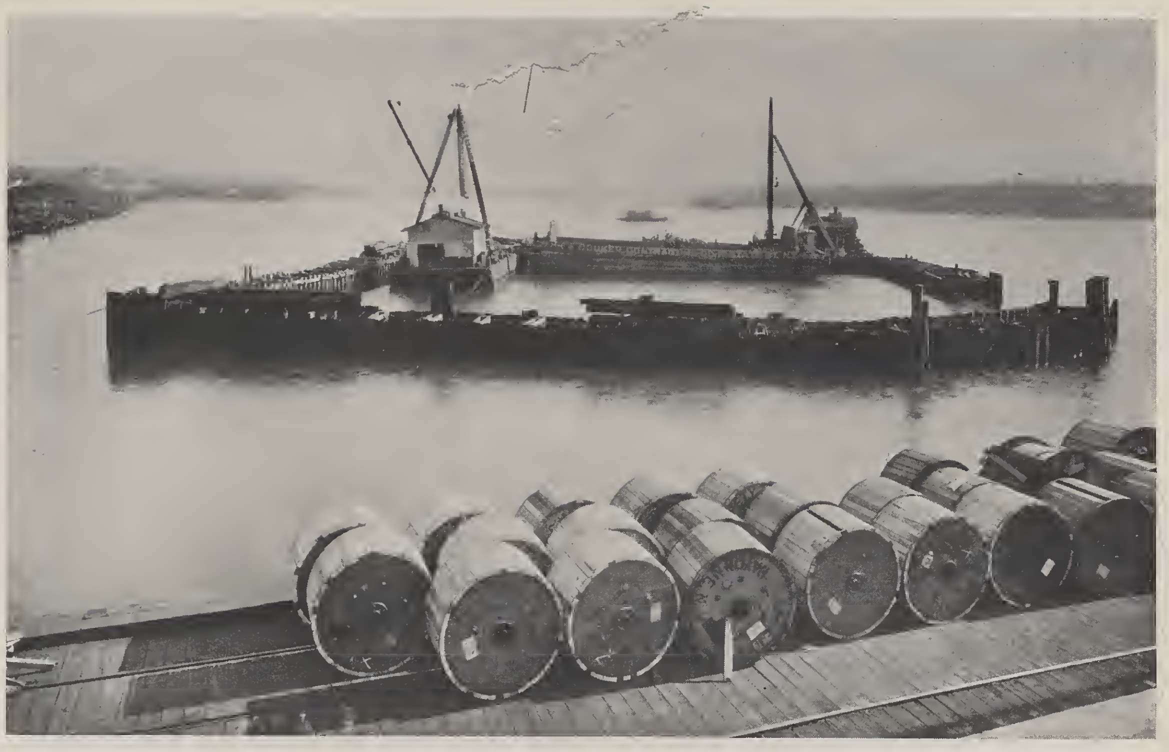
By Act of Congress approved March 2, 1925, the Port Authority was authorized to build and operate the bridge.

On February 1, 1927, a report was rendered on the preliminary studies, with tentative recommendations as to the feasibility of the project, the general location and size, and the approximate cost.

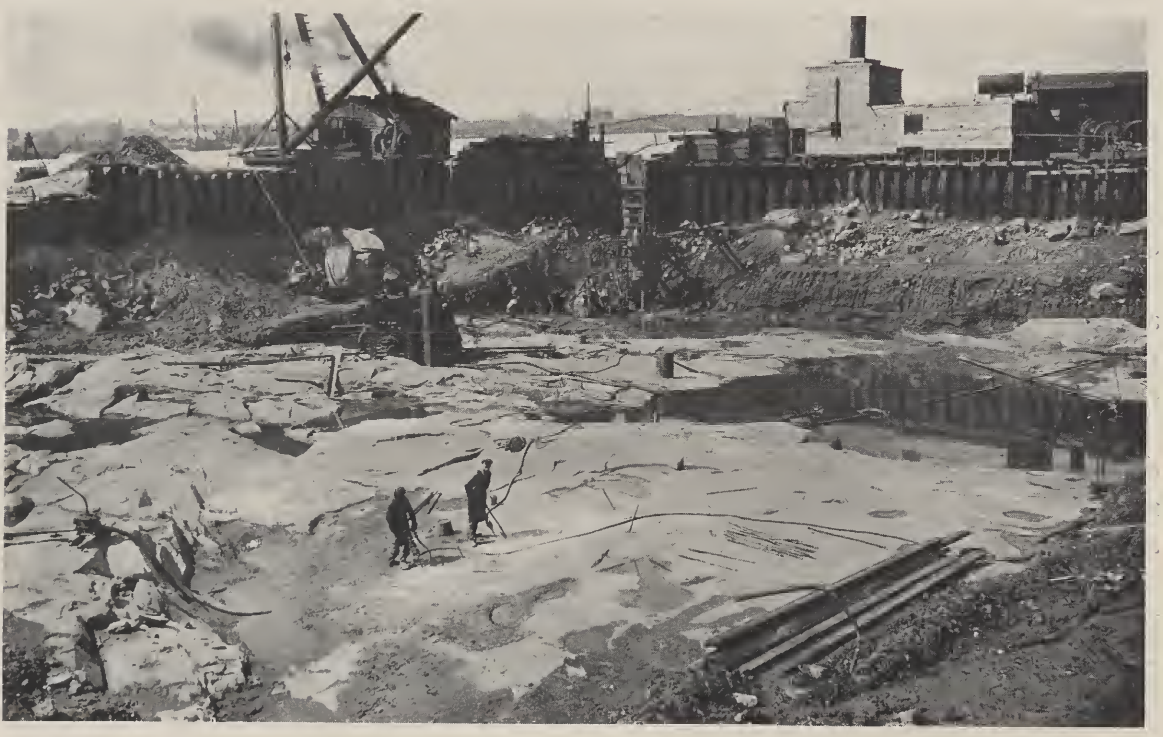
During the remainder of 1927, the preliminary work of design and planning for construction was continued, comprising additional traffic studies, topographical surveys, investigation of subsurface conditions by borings and test pits, revision of design studies and cost estimates, and architectural studies. Conferences were held with representatives of the respective municipalities with a view to securing their cooperation and eventual approval of the approach plans.

By the latter part of 1927, the preliminary work had progressed sufficiently to enable definite conclusions to be drawn as to the economic practicability of the project, the most suitable location, the type and general proportions of the bridge, and to permit steps to be taken toward financing of the project.

In November, 1927, application was made to the War Department for approval of the plans. A public hearing was held at the office of the U. S. Engineer for the Second District, on November 30, 1927, and the application was approved December 31, 1927, by the Chief of Engineers and the Secretary of War.



DRIVING SHEETING FOR COFFERDAM FOR BAYONNE ABUTMENT, NOVEMBER 14, 1928



EXCAVATING AND PREPARING ROCK BED FOR BAYONNE ABUTMENT, MARCH 27, 1929

Financing of the project was effected by the sale on January 5, 1928, of Twelve Million Dollars of Port of New York Authority Four percent Gold Bonds, which, together with Four Million Dollars in authorized advances of the States of New Jersey and New York, furnished the funds for construction of the bridge for initial capacity.

Immediately thereafter further intensive study was given to the elaboration of the most suitable and economical design for the bridge and approaches and to the preparation of detailed contract drawings.

The plans for the approaches and highway connections to the bridge have been developed in cooperation with representatives of the City of New York, the City of Bayonne, the Hudson County Boulevard Commission, Hudson County, Jersey City, and the New Jersey State Highway Department.

The first construction contract was awarded in July, 1928. Since that date construction work to the amount of $6,260,000 has been contracted for, and practically all of the needed property has been acquired.

The work contracted for has included the building of the abutments for the main arch span, the construction of the sub-structures for the approaches, and the fabrication and erection of the steel for the main structure and the approaches. The arch abutments and the approach piers have been completed; fabrication of the structural steel has proceeded rapidly; the erection of the main arch structure is well under way; and erection of approach steel on the Bayonne side has been practically completed.

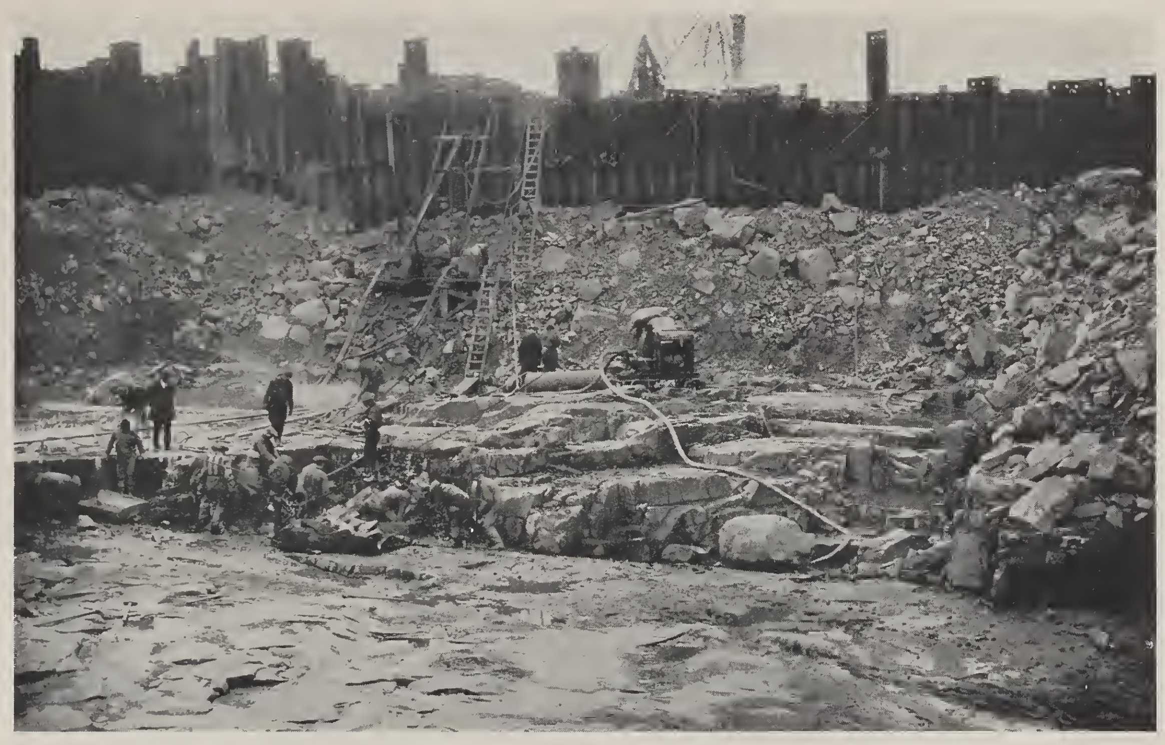
It is confidently expected that the bridge will be completed ready for traffic in the early part of 1932.

LOCATION AND GENERAL DESCRIPTION

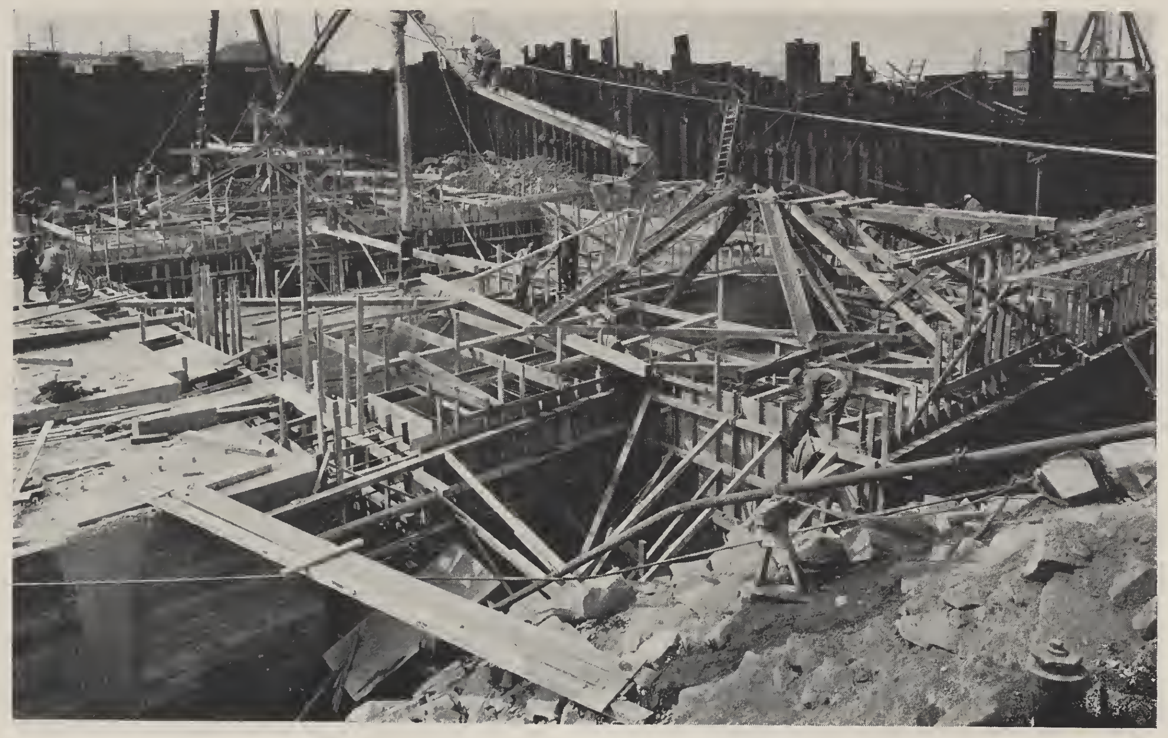
LOCATION

The location of the bridge was selected after careful study of the geographical conditions on both sides of the Kill van Kull. The center line of the structure passes generally through the middle of the blocks between Avenue "A" and the Hudson County Boulevard in Bayonne, crosses the Kill van Kull channel at a considerable skew (58 degrees), and in a northerly and southerly direction, and passes through the block between Morningstar Road and Newark Avenue in Port Richmond. This location necessitates a longer span for the channel crossing than a right angle location, but involves the least amount of destruction of taxable property and is most convenient with respect to important street connections on both sides.

The Bayonne terminus or plaza is located immediately south of the Central Railroad of New Jersey, between Avenue "A" and Hudson County Boulevard, with both of which streets the bridge roadway will connect directly.



EXCAVATING ROCK BED FOR PORT RICHMOND ABUTMENT, JANUARY 11, 1929



CONSTRUCTING PORT RICHMOND ABUTMENT, MARCH 20, 1929

The Port Richmond Plaza is located just south of Innis Street and east of Morningstar Road. The latter, together with Richmond Avenue and Ramono Boulevard, all of which streets the City of New York is planning to widen to 100 feet, will constitute a through artery from the bridge plaza through Staten Island to the Outerbridge Crossing between Tottenville and Perth Amboy. The City of New York also plans to supplement this through artery by a parkway 200 feet wide, located near the westerly side of Staten Island, and extending from the Kill van Kull Bridge Plaza south to the Tottenville Plaza of the Outerbridge Crossing. By way of these and other improved and new highways traffic will move conveniently to points east, west and south on Staten Island, and across the Arthur Kill to the Mainland at Elizabeth by way of The Goethals Bridge and at Perth Amboy by way of The Outerbridge Crossing.

GENERAL DESIGN

The bridge structure comprises a single steel arch over the Kill van Kull, flanked on each side by approaches consisting of steel plate girder spans supported on concrete piers.

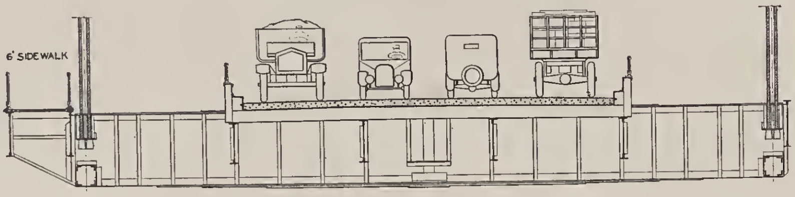
The Port Richmond approach is approximately 2,900 feet in length and the Bayonne approach approximately 3,700 feet, making the total length of the structure from plaza to plaza approximately a mile and two-thirds. The roadway profile consists principally of straight 4 per cent. grades, with connecting vertical curves at the ends, and with a hyperbolical curve over the arch structure.

The main structure over the Kill van Kull will be a two-hinged arch, and will have a span of 1,675 feet between the centers of bearing of the arch shoes. This span is nearly 700 feet longer than that of the famous Hell Gate Arch, and compares with other large arch spans as follows:

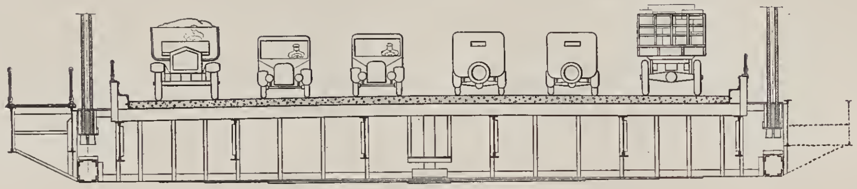
	Length of Span Between Centers of End Pins
Eads Bridge, St. Louis (opened 1874)	520 ft.
Niagara Bridge, Niagara Falls, N. Y. (opened 1898)	840 ft.
Hell Gate Bridge, New York (opened 1916)	977 ft. 6 in.
Sydney Harbor Bridge, Australia (under construction)	1,650 ft.
Kill van Kull Bridge	1,652 ft. 1 in.

The arch is composed of two arch trusses, spaced 74 feet on centers, with a rise of 274 feet from the center of bearing to the crown of the lower chord. Each truss has a depth of 37½ feet at the crown, and the depth increases slightly toward the abutments, the panel point curve of each chord being a true parabola. At the crown of the arch, the upper chord will reach a height of 327 feet above the water.

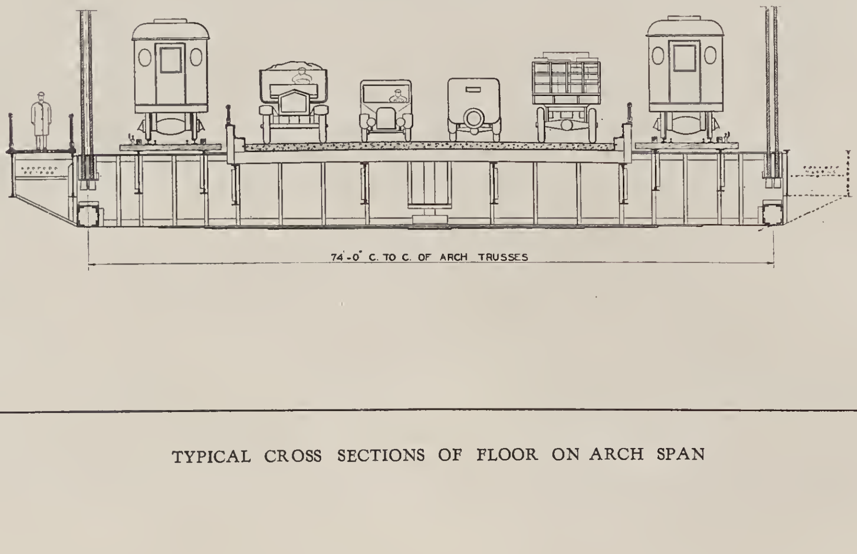
The web members of the arch trusses are arranged in forty equal panels. Wind bracing is provided between the trusses at the upper and lower chords. Sway bracing will be used between the two trusses at the five panel points near each end, and stiff portals at the points where the floor passes through the arch. The central part of the floor is suspended from the arch trusses by means of wire rope hangers.



INITIAL STAGE – 40 FT. ROADWAY



ULTIMATE STAGE – 65 FT. ROADWAY



ALTERNATE ULTIMATE STAGE
40 FT. ROADWAY AND 2 RAPID TRANSIT TRACKS

TYPICAL CROSS SECTIONS OF FLOOR ON ARCH SPAN

TRAFFIC CAPACITY

On the arch structure and on the approaches the bridge is to have a single deck. In the tentative report of February 1, 1927, it was proposed that the deck be designed for a capacity of six lanes of vehicular traffic and two sidewalks. Further study of possible requirements for rapid transit passenger traffic, and conferences with the North Jersey Transit Commission and the Suburban Transit Engineering Board, led to the conclusion that it was desirable to make provision for rapid transit service over the bridge. It was found feasible, without undue increase in cost, to make the bridge structure strong enough to carry four lanes of vehicular traffic and two rapid transit tracks, and the bridge has accordingly been designed for such ultimate capacity. In order to permit opening the bridge at the lowest initial cost, and with the greatest degree of flexibility for adapting the ultimate capacity to the needs of future traffic developments, the bridge will be constructed initially with a four-lane vehicular roadway, 40 feet wide between curbs, and with one sidewalk located on the west side of the bridge, outside of the arch truss. The roadway can later be widened to a seven-lane capacity, or the four-lane roadway can be supplemented by two rapid transit tracks. Provision for electric conduit lines is made beneath the sidewalk. In the future additional conduits or another sidewalk on the east side of the bridge can be added if needed.

CLEARANCES

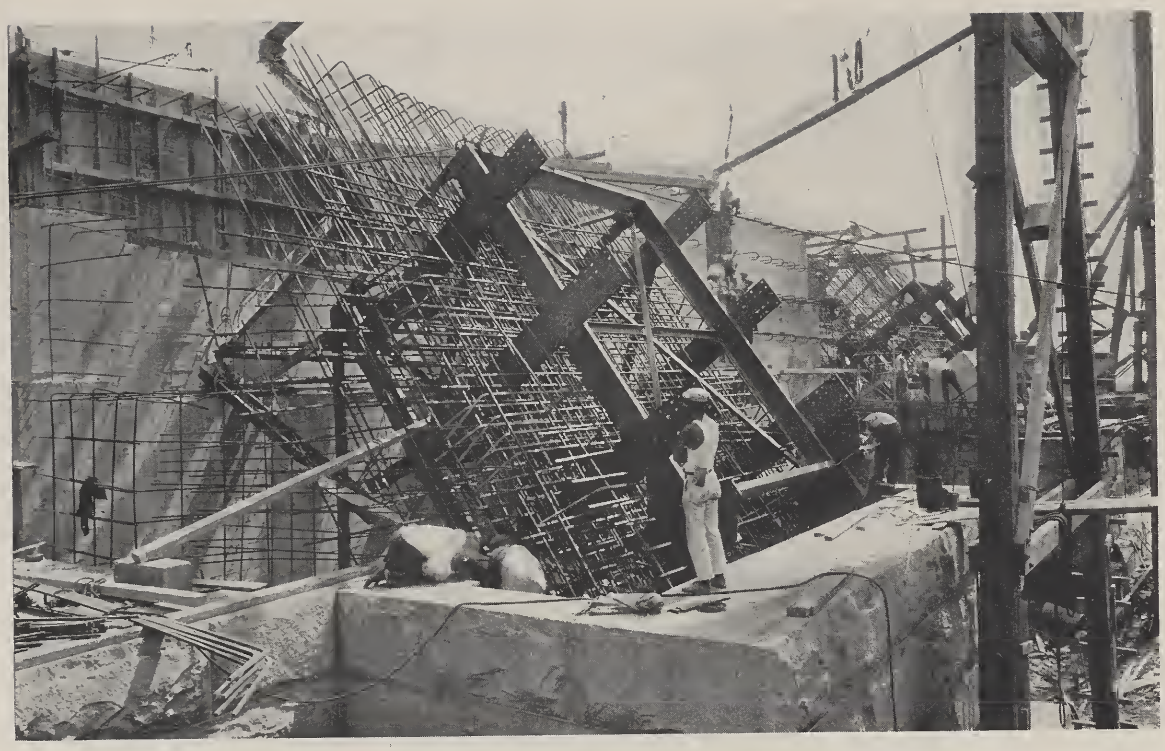
The Kill van Kull is an important waterway within the Port District. It is the main gateway to Newark Bay and the Arthur Kill, and annually carries a greater tonnage than passes through the Suez Canal. Because of the importance of this waterway, special study was given to secure adequate clearances. The arch abutments are located well back of the U. S. Pierhead lines, leaving the entire waterway free of pier obstructions. The center of the span has a clearance of 150 feet above mean high water, under extreme conditions of full load on the bridge and lowest temperature. At other points the minimum clearances under the same conditions are as follows:

143½ feet at any point within the present 400 ft. channel,
140 feet at any point within the proposed 800 ft. channel,
135 feet at any point within a channel 1,000 feet wide.

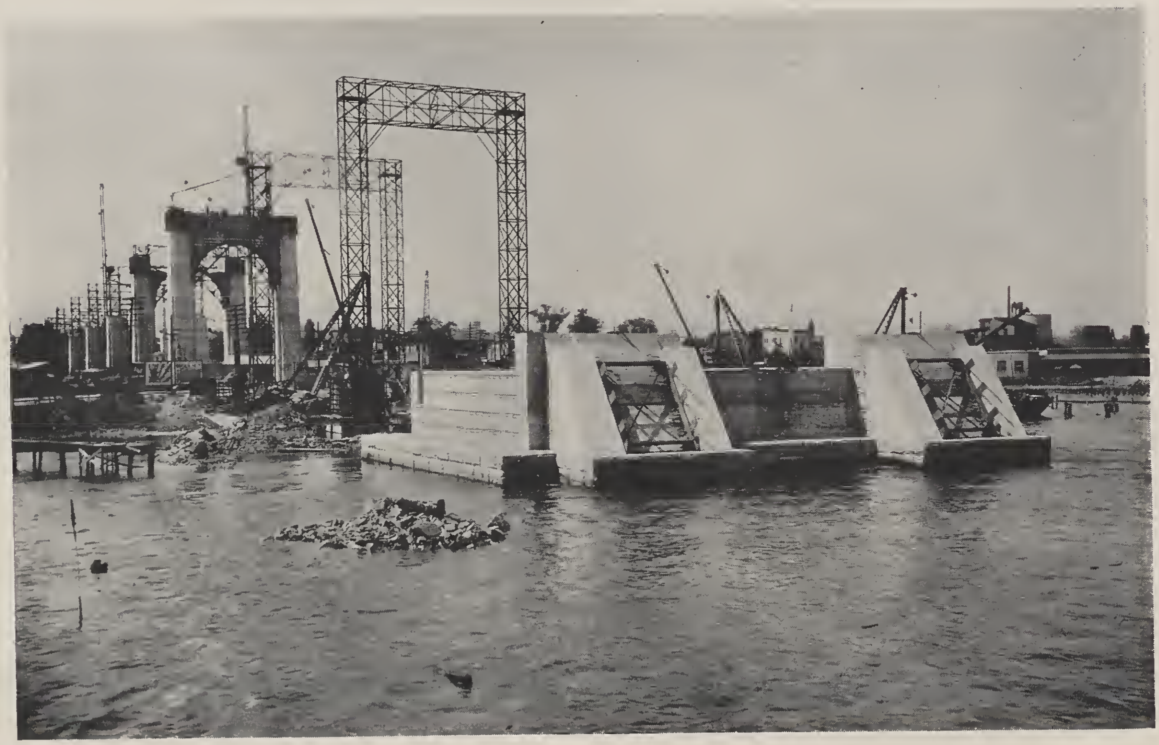
These clearances are considered ample for navigation and are 15 to 20 feet in excess of those which exist under the East River Bridges and under many other bridges over important navigable waterways.

SELECTION OF ARCH DESIGN

The arch design for the main structure was selected after elaborate study and comparison with alternate designs of other types of bridge. During 1927, detailed design studies and estimates of cost were made for the cantilever, suspension and arch types.



BAYONNE ABUTMENT—STEEL ANCHOR FRAME AT SKEWBACK, JULY 18, 1929



PORT RICHMOND ABUTMENT, READY FOR ERECTION OF ARCH—APPROACH PIER CONSTRUCTION IN BACKGROUND, AUGUST 20, 1929

Early comparison of this nature showed that the cantilever design would be the most expensive, and, since it would also be æsthetically inferior to an arch or suspension bridge, it was eliminated from further consideration.

The comparison in cost between a suspension design and an arch design was somewhat closer and consideration was given to the possibility of obtaining competitive bids on the two designs. In the preparation of the designs it was endeavored to make them on as fair and equitable a basis as was possible under the given conditions as regards traffic capacity, strength and appearance.

The degree of rigidity in any bridge design is of importance, affecting not only the traffic, but having a bearing upon the durability of the bridge. The suspension design is much more flexible than the arch bridge. In the studies prepared for this bridge the calculated deflections for a suspension bridge were several times those for an arch bridge. For vehicular traffic the rigidity of the suspension design would be ample, but it is questionable as to whether it would be sufficient for the much heavier concentrated loads from rapid transit trains.

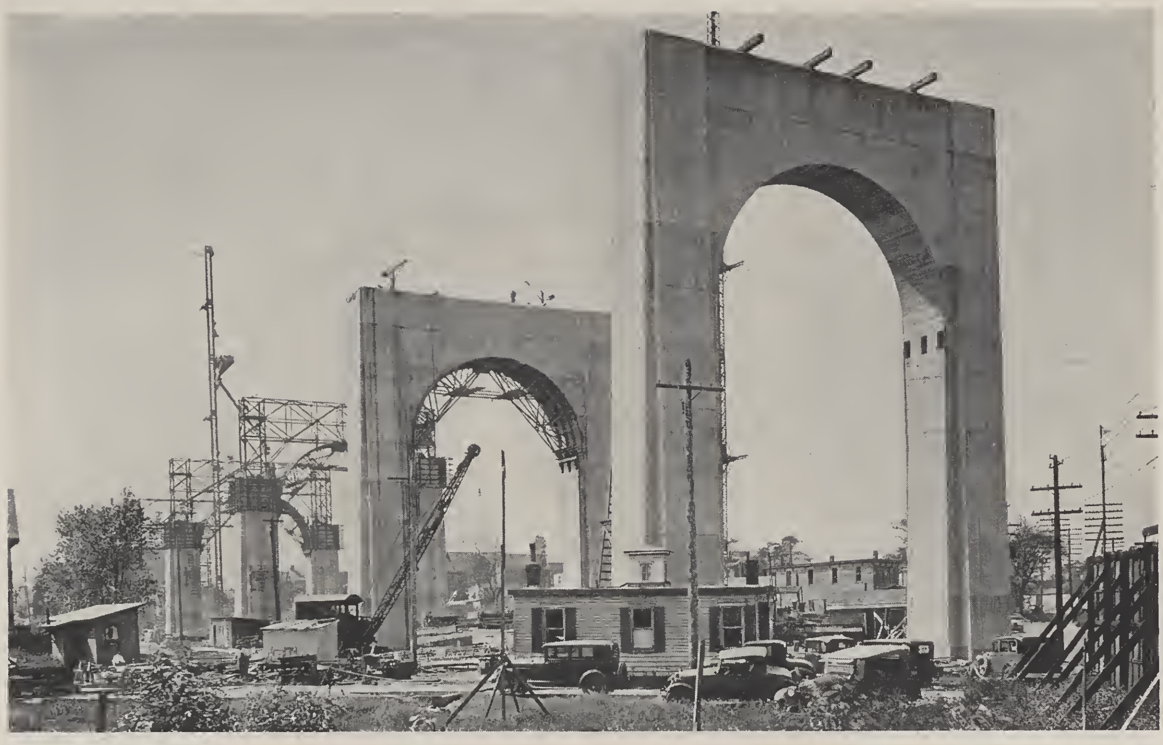
The estimates indicated that a suspension bridge comparable to the arch would cost from one million to one million and a half dollars more than the arch, and the latter design was therefore adopted.

The presence of bed rock near the surface, affording solid foundation to resist the arch thrust, is particularly favorable to the arch design at this location. Under these conditions the arch can deliver its thrust almost directly to solid rock whereas the suspension type would require massive anchorage piers to resist the cable pull. The arch abutments are designed to present a massive appearance, for architectural reasons, but are of solid masonry only for sufficient height to support the arch shoes, and the upper portions are to be hollow structures of comparatively inexpensive concrete construction with granite facing.

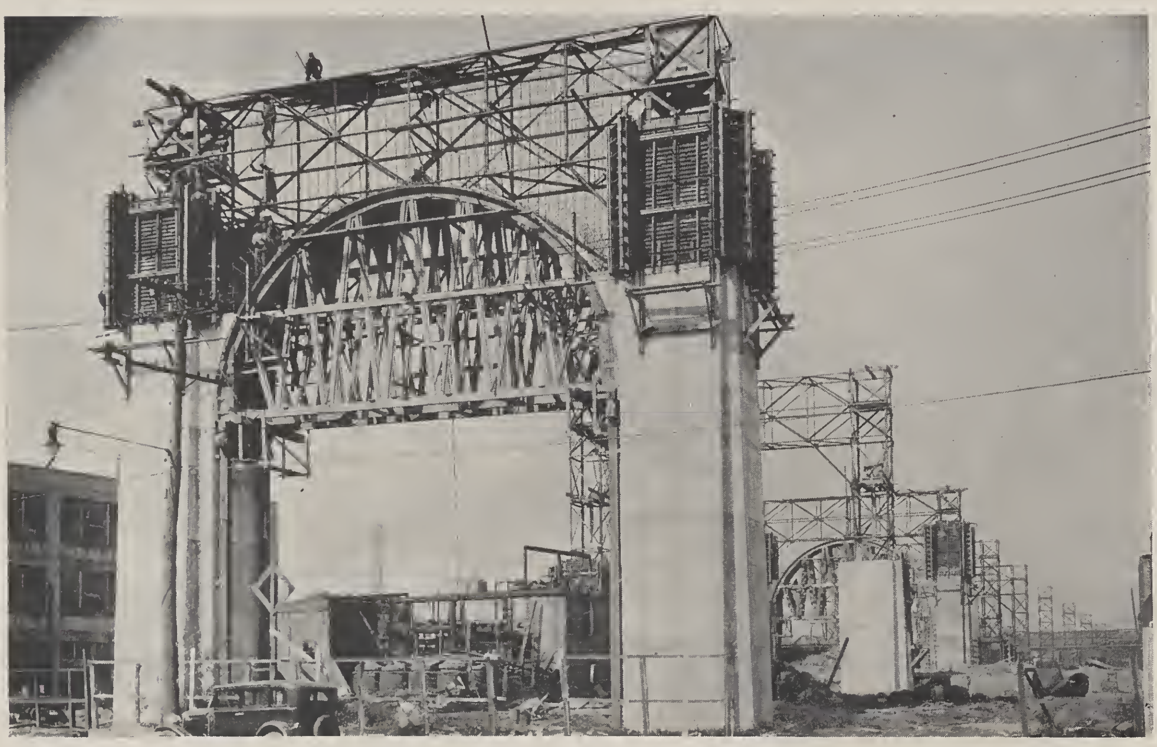
BAYONNE APPROACH PLAN

At the request of Mayor Bert J. Daly, of the City of Bayonne, a Committee was formed to develop a plan for the Bayonne Approach and highway connections thereto. This Committee was composed of Hon. G. E. Keenan, Commissioner of the City of Bayonne; Hon. Joseph Minton, Commissioner of the City of Bayonne; Walter L. Clarkson, City Engineer of Bayonne; T. J. Wasser, Supervising Engineer of the Board of Chosen Freeholders of Hudson County; Frank J. Radigan, County Engineer of Hudson County; Philip Guise, City Development Engineer of Jersey City; H. W. Hudson, Engineer of the New Jersey State Highway Commission, and the undersigned, representing the Port Authority.

The Committee rendered a report on October 17, 1929, together with a plan for the approach. The plan provides for ultimate facilities which eliminate grade crossings in the distribution of traffic between the bridge and the two main arteries of traffic in



CONSTRUCTION OF PORT RICHMOND APPROACH PIERS, SEPTEMBER 10, 1929



CONSTRUCTION OF BAYONNE APPROACH PIERS, SEPTEMBER 25, 1929

Bayonne. In the initial stage, a roadway 40 feet wide is provided extending from the bridge structure to a point south of West Sixth Street, where it branches into two 40-ft. roads, one connecting with Avenue "A" and the other with the Hudson County Boulevard. The space between the two branches forms part of an open plaza. Margaret Street, Fifth, Sixth and Seventh Streets, between Hudson Boulevard and Avenue "A," are closed in whole or in part in order to avoid interference with the approach structure and the plaza. Two side roads, adjacent to the approach, are provided for the convenience of city traffic in the block between West Fourth and Margaret Streets.

At a later date, when traffic will have become heavier, a special "onbound" roadway will be constructed, starting from Hudson Boulevard at a point south of West Seventh Street, passing under the branch road between Avenue "A" and the bridge, and joining the main approach south of Margaret Street. Thus traffic approaching the bridge from Hudson Boulevard will be accommodated without any grade crossing of the traffic between the bridge and Avenue "A." The main approach roadway north of West Fourth Street will also later be widened from 40 feet to 60 feet.

PORT RICHMOND APPROACH PLAN

The Port Richmond Approach Plan was developed in collaboration with Mr. Theodor S. Oxholm, Consulting Engineer to the Borough of Richmond, Mr. Thomas B. Oakley, Engineer of the Borough of Richmond, and Mr. Arthur S. Tuttle, Consulting Engineer of the Board of Estimate and Apportionment of the City of New York.

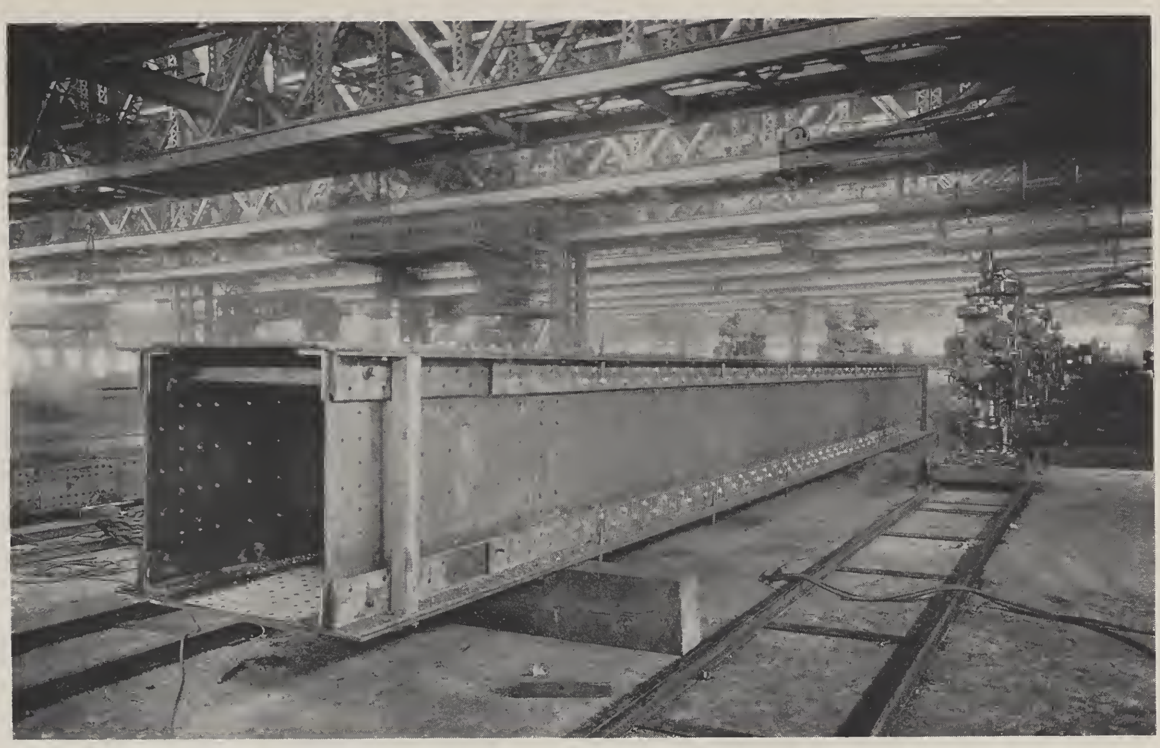
The plan provides for an open plaza, bounded by Innis Street, Hooker Place, Morningstar Road, and Trantor Place. A roadway 60 feet wide is provided connecting the approach with Morningstar Road. An additional roadway 60 feet wide, which branches off from the approach immediately south of Innis Street, crosses the plaza toward the east and makes direct connection with the proposed West Shore Boulevard, 200 feet wide, which is planned to be built by the City of New York from the plaza south to Tottenville.

COST ESTIMATES

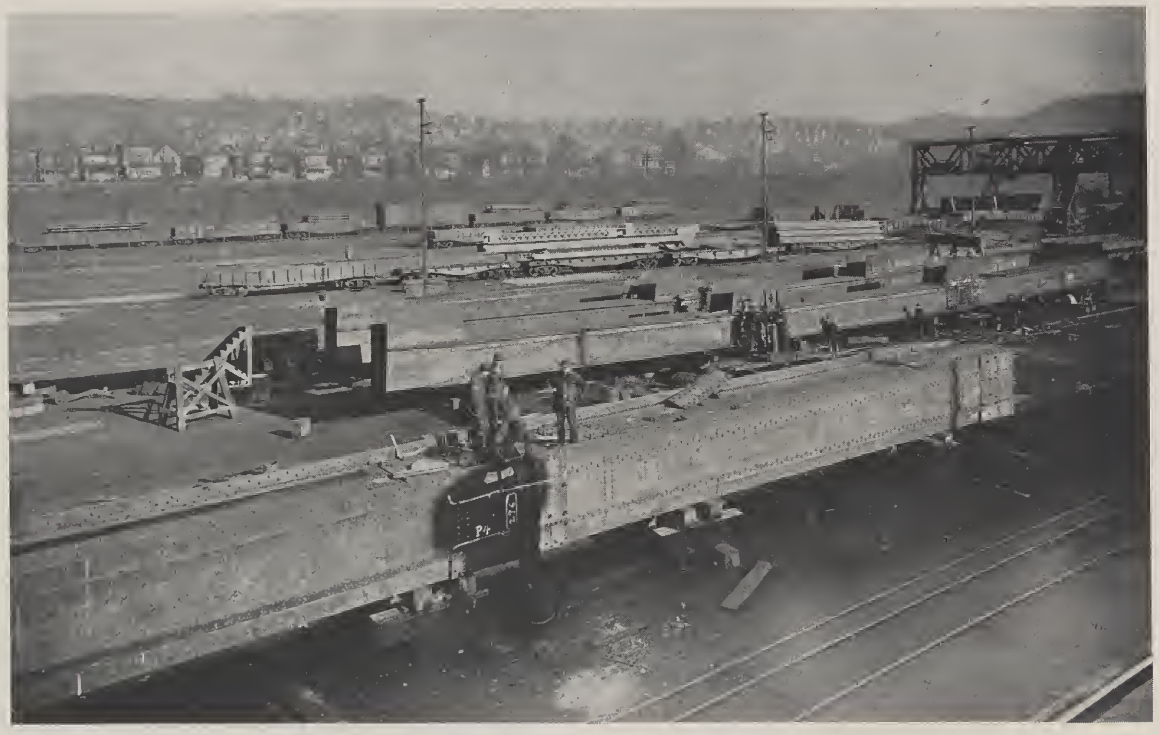
The cost of construction has been estimated by using prevailing prices for labor and materials and basing the cost of real estate upon a careful appraisal made by the Real Estate Department of the Port Authority with the advice of expert appraisers.

In these estimates provision is made for contingencies which may arise and for interest during construction. The contract prices for the work already under construction are within the estimated cost and it is believed that the estimates cover the entire cost as closely as can be foreseen at this time.

As indicated in the following tabulation the initial cost of the bridge and approaches with a four-lane vehicular roadway, is estimated at $16,000,000. When necessary, and



FABRICATION OF ARCH STEEL—DRILLING COVER PLATES OF THE UPPER CHORD, AUGUST 1, 1929



FABRICATION OF ARCH STEEL—ASSEMBLY OF CHORD SECTIONS, AND DRILLING OF CONNECTIONS, NOVEMBER 5, 1929 when the additional revenues from traffic justify it, the bridge may be enlarged to the full design capacity at an estimated cost of about $2,000,000.

ESTIMATED INITIAL COST

Main Bridge—Construction	$ 6,640,000
Approaches—Construction	4,010,000
Total Construction	$10,650,000
Engineering, Administration and Contingencies	$1,610,000
Real Estate	2,400,000
Interest during Construction	1,340,000
Total Estimated Initial Cost	$16,000,000

CONSTRUCTION WORK

CONSTRUCTION CONTRACTS

The following is a list of the principal construction contracts let to date:

Main Bridge Abutments
    Contractor, H. P. Converse.

Steelwork of Bridge and Approaches
    Contractor, American Bridge Company.

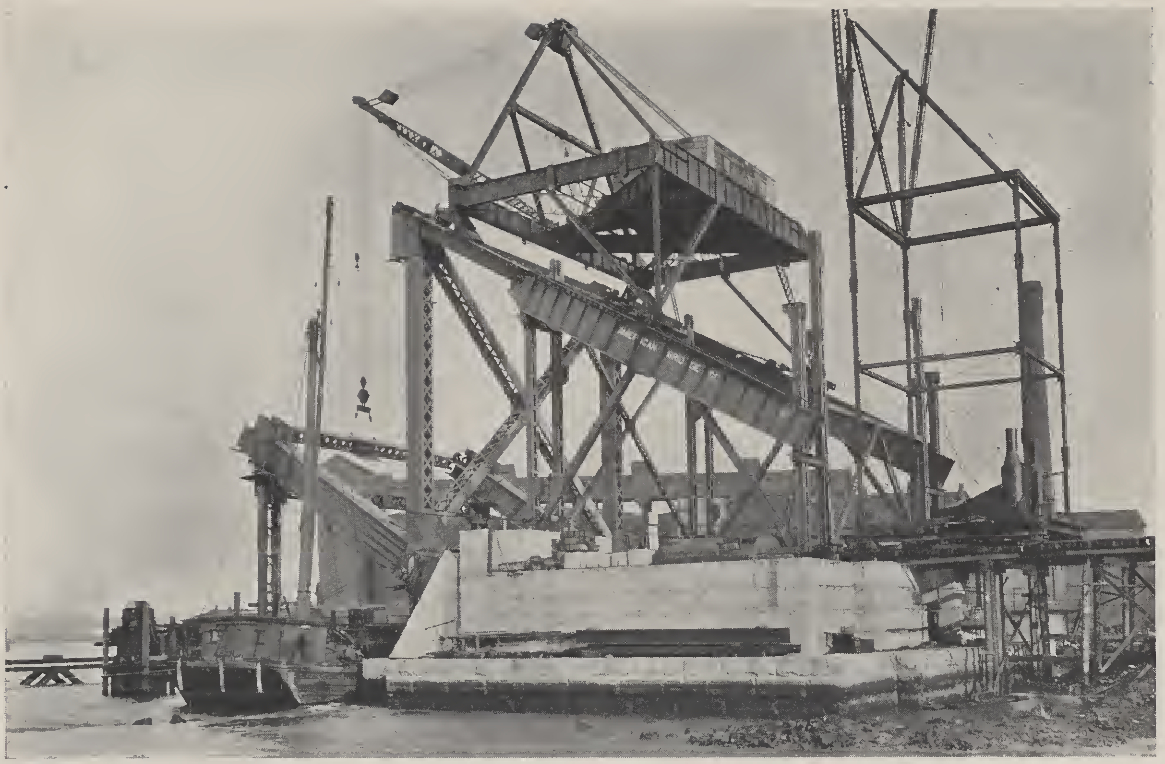
Bayonne Approach Piers
    Contractor, P. T. Cox Contracting Company, Inc.

Port Richmond Approach Piers
    Contractor, Arthur McMullen Company.

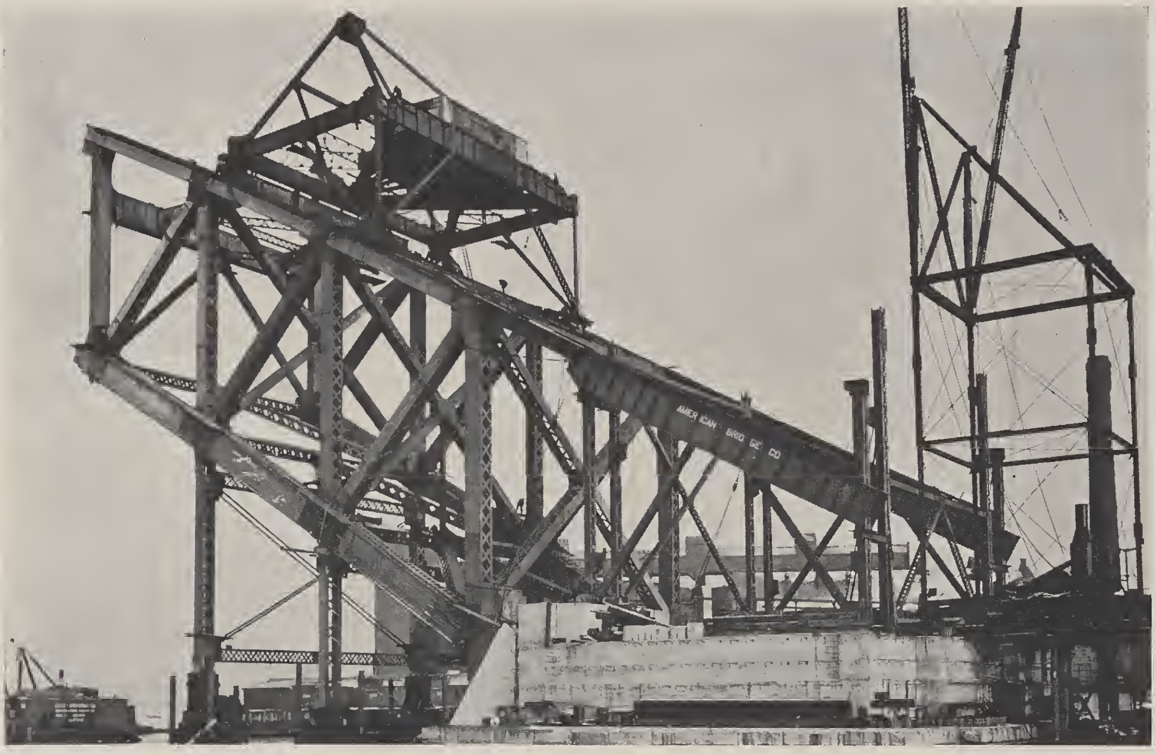
TEST PITS AND BORINGS

A contract was awarded in February, 1928, to the Giles Drilling Company, Inc., for test borings to determine subsurface conditions more accurately and completely than had been done by the preliminary borings. This contract included borings at the sites of the abutments of the main bridge, and along both approaches, and the work was completed on March 26, 1928.

At both abutments the bed rock consists of a dense, hard diabase known as "Palisades trap," the top ledge of which is at shallow depths. On the Bayonne side the bed rock was found to be from 10 to 14 feet below mean low water and the overburden to vary from nothing to about five feet in depth. On the Port Richmond side the bed rock is from 18 to 25 feet below mean low water and the overburden from five to eight feet in depth. At both arch abutments the overburden consists of silt and boulders.



ARCH ERECTION, PORT RICHMOND, NOVEMBER 20, 1929



ARCH ERECTION, PORT RICHMOND, DECEMBER 26, 1929

The subsurface investigations by borings on the sites of the approaches were supplemented by a number of test pits, the work on the Port Richmond side being done by W. C. Conner and that on the Bayonne side by B. Brancatella. On each side of the river, the bed rock was found to be of the same character as that at the abutment sites, but at depths varying from elevation +8 to —17 on the Port Richmond side, and from elevation +3 to —10 on the Bayonne side. The overburden on each side was of clay, sand and boulders. Additional borings along the two approaches were made under a contract entered into in December, 1928, with Phillip J. Healy, Inc., in order to check the irregularity of the bed rock and to determine at what elevation foundations could be constructed at each pier.

CONSTRUCTION OF ARCH ABUTMENTS

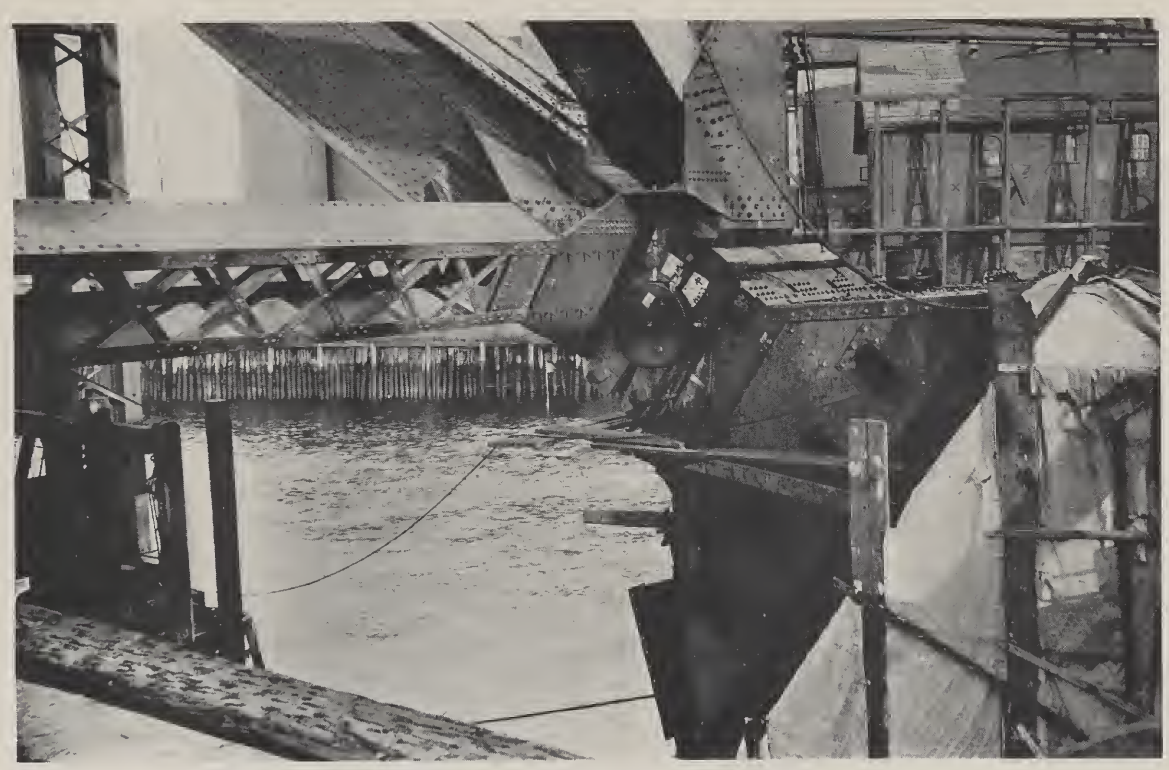
Because of the presence of the solid bed rock at shallow depths, so favorable to the arch design, the construction of the foundations for the arch abutments was not difficult. The two abutments are identical in plan, each about 133 feet by 107 feet in extreme dimensions at the base, and each constructed of concrete masonry, faced with granite from a level 6 feet below mean low water.

The foundation work for each abutment was carried on inside a cofferdam, the walls of which were made with double lines of steel sheet piling filled with silt and sand. The cofferdams were sufficiently rigid so that they required no interior bracing. On the Bayonne side, the cofferdam was 204 feet by 180 feet overall, with the lines of sheeting 10 feet apart. On the Port Richmond side, the cofferdam was 214 feet by 190 feet overall, with the lines of sheeting 15 feet apart. The sheeting was from 18 to 23 feet in length for the Bayonne cofferdam, and from 28 to 30 feet in length for the Port Richmond cofferdam. The sheeting was 16 in. by 33.3 lb. Lackawanna steel sheet piling. Timber pile bents, 8 ft. 6 in. on centers, supported the whaling timbers used for driving the sheeting and afforded bracing for each wall. After the sheeting was driven, the two lines were connected by steel tie rods, located at the bents, and the walls were then filled.

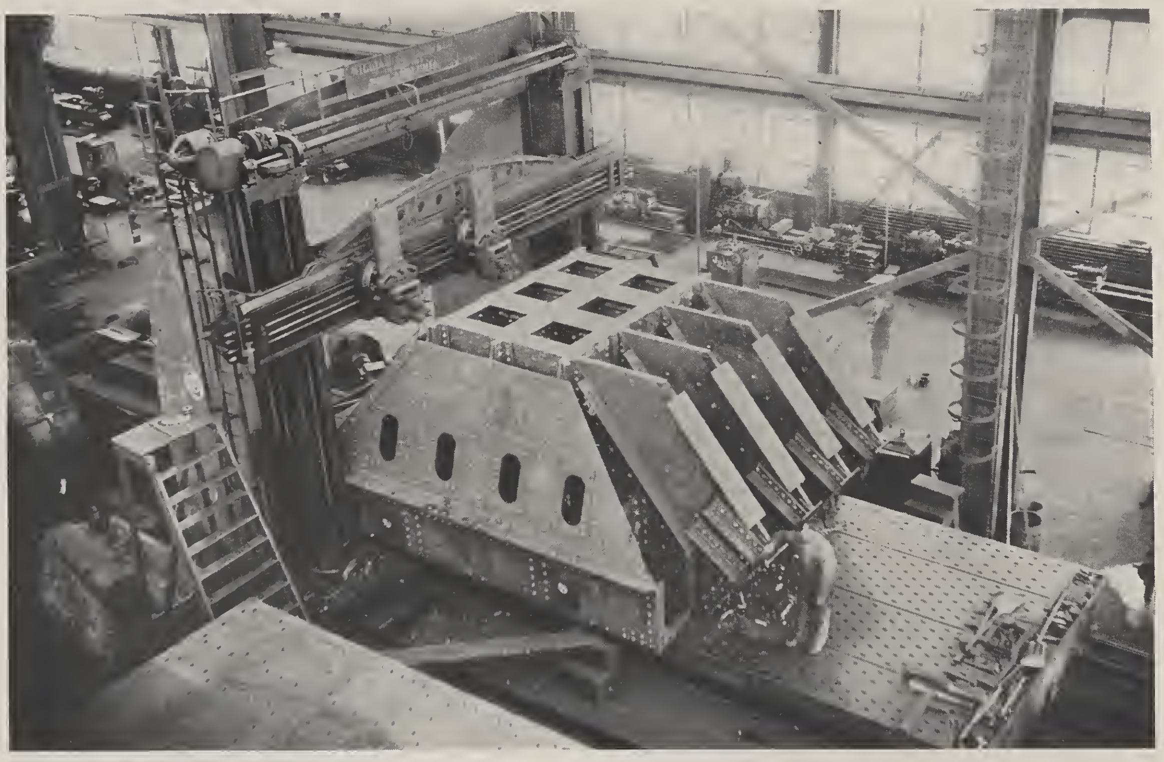
On account of the scant overburden on the bed rock at the site of the Bayonne abutment, additional material had to be deposited there to provide sufficient cover to support the piles and sheeting when they were driven.

On the Port Richmond cofferdam, many sections of the sheet piling came to rest upon boulders, but, in general, the sheeting was driven to refusal in hard pan. By construction of an embankment of overburden along the sheeting before the cofferdam was unwatered, and by careful maintenance of this embankment during the construction, leaks were prevented and no difficulty was experienced in keeping the cofferdam water-tight.

After the Port Richmond cofferdam was unwatered, the silt was cleaned off the rock ledge by a 2-inch high-pressure water jet and by hand excavation, although in some



ARCH HINGE AND SHOE ON PORT RICHMOND ABUTMENT, NOVEMBER 20, 1929



MACHINING A STRUCTURAL STEEL SHOE FOR ARCH SPAN areas overlying the deeper parts of the bed rock the gravel was so thoroughly compacted that paving breakers were required to loosen it. It was also necessary to blast off the top layer of rock over more than half of the foundation area because a clay seam was found in the rock. This clay seam started as a feather edge, east of and approximately parallel to the bridge axis and extended in an inclined plane into the rock toward the west, to a maximum depth of about eight feet below the original rock ledge.

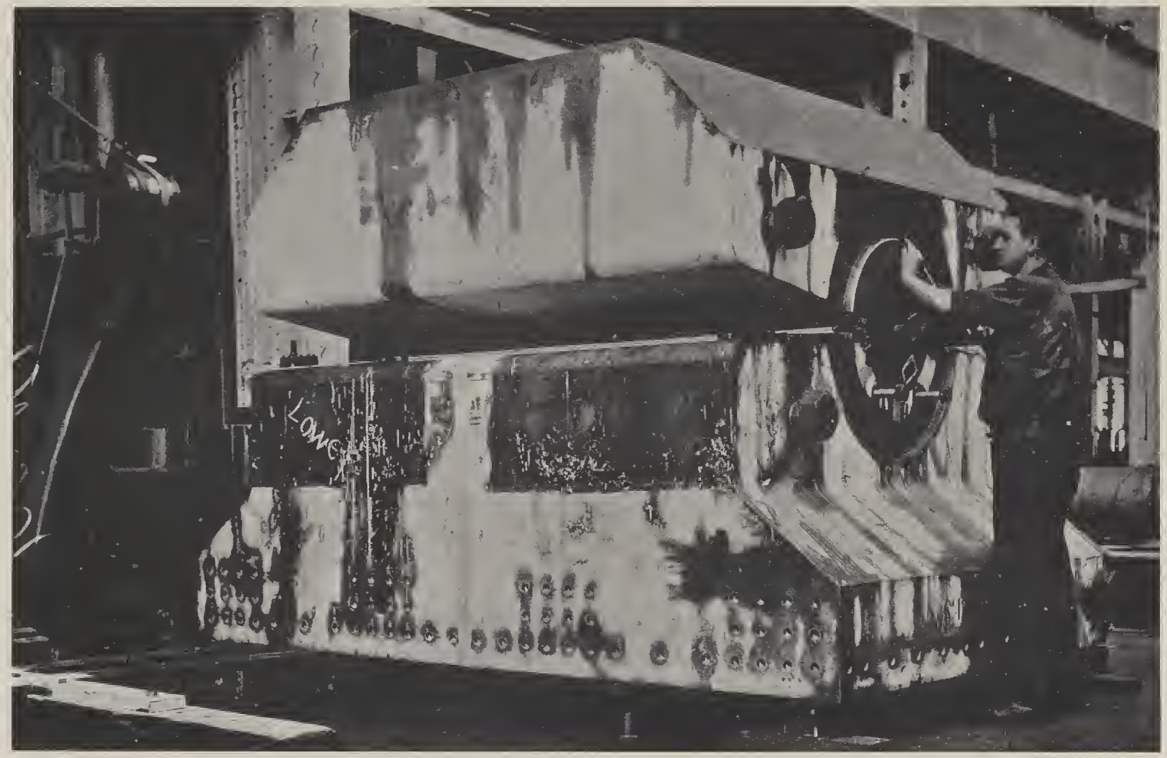
On the Bayonne side the depositing of additional cover over the rock and the placing of an embankment inside the cofferdam sealed it completely. The surface of the bed rock was cleaned almost entirely by use of high pressure water jets, and the rock was found to be entirely free of seams or faults. Because the surface was relatively level, however, pits were blasted in the rock to provide satisfactory resistance to the horizontal thrust of the arch.

This contract included only the portion of the abutments up to the top of the skewbacks, 28 feet above mean low water, providing sufficient abutment mass for the full dead load thrust of the arch.

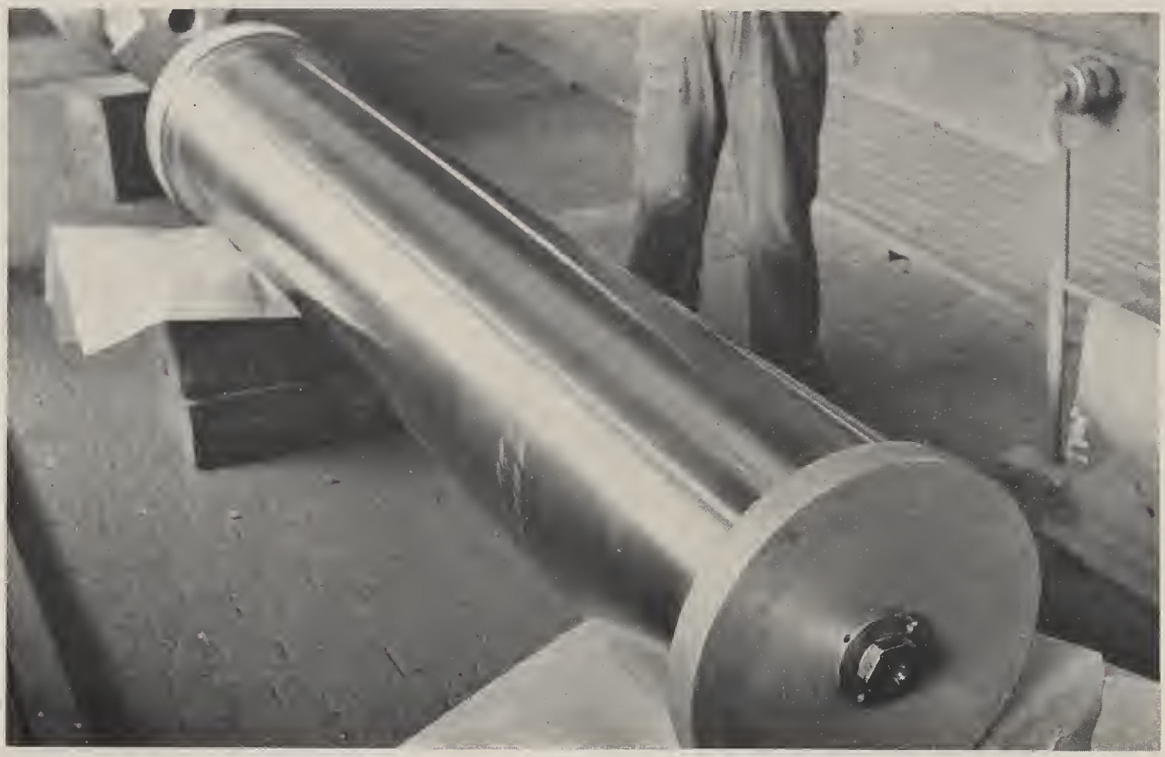
Since both abutments were located in the water, the Kill van Kull afforded the most convenient as well as the most economical facility for the transportation of materials and the handling of the contractor's plant. Floating equipment was used throughout, giving easy access to all parts of the work and complete flexibility in adapting the plant to the changing construction operations of pile driving, excavation, concreting and accurate setting of granite and structural steel. Dredging was necessary from the channel to the site of the Port Richmond abutment, to provide for the draft of the plant equipment, but no other preparatory work at the site was needed for the contractor's plant.

Gravel, sand and cement were all delivered in bulk, the gravel and sand being transported by scows and the cement by covered canal boats. These vessels were towed alongside the concreting plant, and the materials transferred directly to storage bins above the mixer. The bulk cement was hoisted from the boat by ordinary clam-shell buckets, working through the hatches, and was measured by being weighed in a special device. This weighing device was equipped with outlets to permit the air to escape as the cement flowed in from the storage bin, in order to prevent dispersion of the cement and to facilitate filling the weighing bin. From the weighing device the cement was dumped directly into the mixer. Gravel was measured by weight and sand by volume in an inundator. The concreting plant was assembled on a single barge, formerly a car float, 32 feet wide by 205 feet long. A single 150 H. P. boiler plant was provided on this barge for all the engines, operating a material handling hoist having a 75-ft. boom with a three-drum hoisting engine, a 2 cubic yard concrete mixer, and a chuting system tower 100 feet high equipped with a 1 cubic yard hoisting skip, and a boom 115 feet long to support the chutes. Charging bins and an inundator were provided over the mixer.

Each abutment was constructed as two main units, divided by a construction joint four to six feet wide along the axis of the bridge. Each unit was concreted in successive



FORGED STEEL BEARING BLOCKS AND PIN FOR ONE HINGE OF ARCH, ASSEMBLED AT THE SHOP



16-IN. DIAMETER FORGED STEEL PIN FOR AN ARCH HINGE sections, with shear keys perpendicular to the line of thrust of the arch, the volume in single sections varying from 240 to 450 cubic yards.

A special feature of the abutments is the provision of structural steel frames for supporting the steel arch shoes at the skewbacks. These frames are 15 feet 2 inches by 18 feet in plan, and are embedded 11 feet into the concrete. The frames were erected in place as the construction proceeded, additional steel members being provided to assist in their erection, and the concrete was poured around them. The skewback faces were finished two and one-half feet away from the bearing planes for the arch shoes. After the shoes were erected on the frames and riveted to them, the spaces between the shoes and the abutments were filled with concrete.

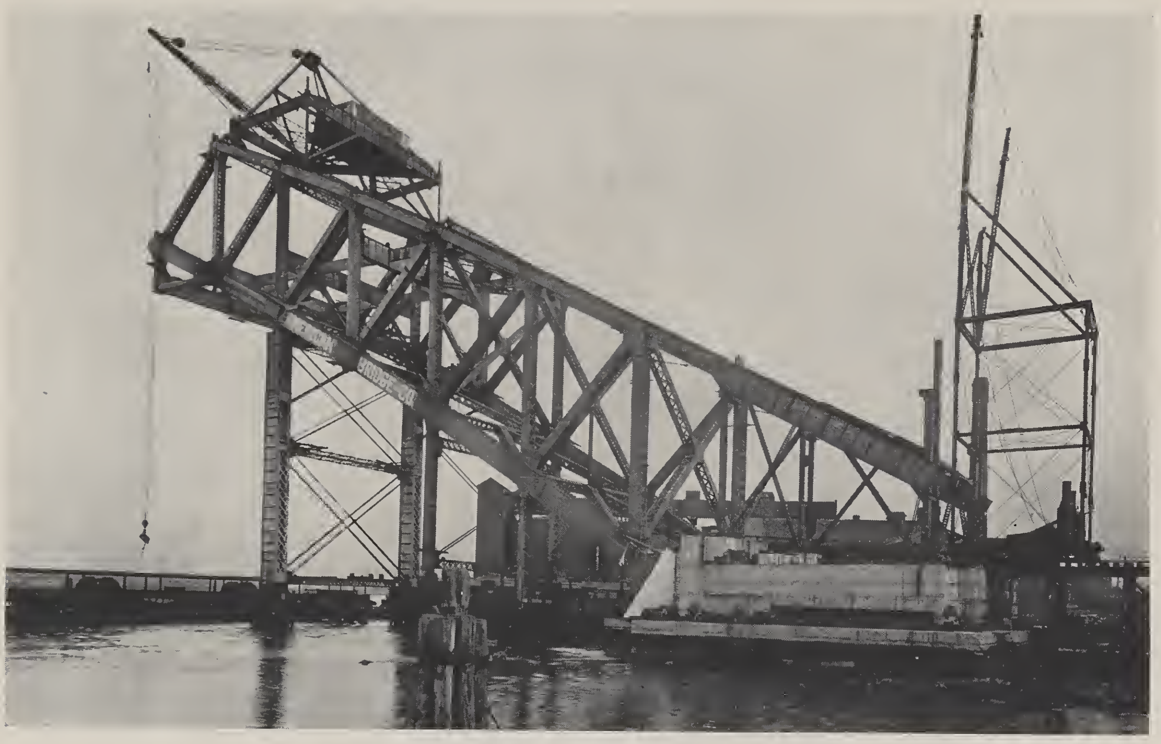
Bids for construction of the abutments were opened July 5, 1928, fifteen tenders having been made. Award of the contract was made to H. P. Converse, Boston, Mass., the low bidder, on July 12, 1928. Construction was formally started, with official ground breaking ceremonies, on September 18, 1928. The Port Richmond cofferdam was pumped dry on November 24, 1928, and concreting was started on February 19, 1929. The Bayonne cofferdam was pumped dry on January 22, 1929, and concreting was started May 18, 1929. Concreting was completed in May, 1929, for the Port Richmond abutment, and in July, 1929, for the Bayonne abutment.

STEELWORK FOR ARCH SPAN AND APPROACHES

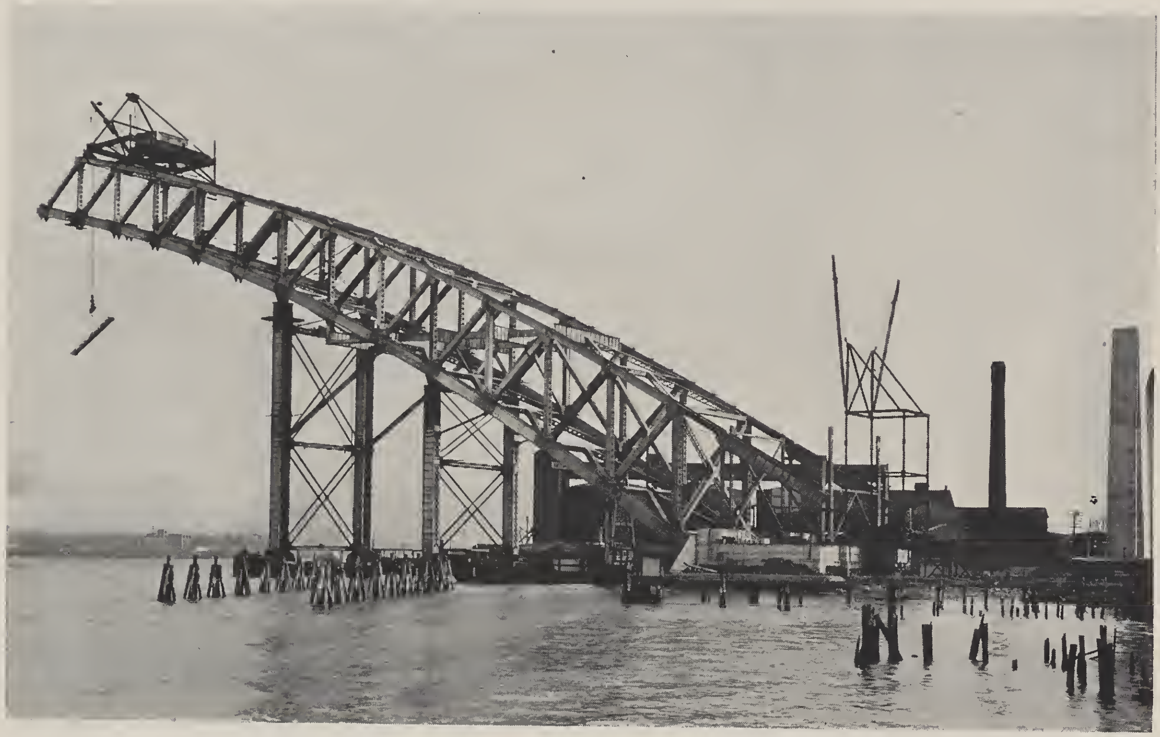
A contract for the fabrication and erection of the structural steel for the arch span and for the approaches was advertised in September, 1928, and bids were received November 19, 1928. Three proposals were received, and the contract was awarded November 21,-1928, to American Bridge Company, the low bidder.

The arch span, as noted previously, is a parabolic two-hinged steel arch. The bottom chord is the principal arch member, and, at the abutments, supports the entire arch thrust. It is composed entirely of carbon-manganese steel, and has a cross sectional area of 980 square inches at the abutments, and 580 square inches at the crown. The hinges are formed by pins 16 inches in diameter, bearing upon heavy steel forgings which insure uniform bearing over the supporting structural steel webs. The arch shoes upon which the lower pin bearings are erected are of riveted structural steel. Each shoe is 10 feet high and 15 feet by 18 feet at the base and weighs about 120 tons. Each of the forged pin bearings weighs about 60 tons. The top chords of the trusses are of silicon steel, with cross sections varying from 272 square inches to 421.5 square inches, the maximum section being determined by the erection stresses and being 38.5 square inches greater than that required for the arch alone. The web members of the trusses, and the bracing between the trusses are of carbon steel. The floor beams and stringers which support the deck slabs are partly of silicon and partly of carbon steel.

The arch is designed to act as a three-hinged arch under the dead load of the trusses and the bracing between them, and as a two-hinged arch for the reamining dead load



ARCH ERECTION, JANUARY 29, 1930



ARCH ERECTION, MARCH 26, 1930

and the live load. In order to obtain the three-hinged condition, a temporary pin connection will be made at one point on the lower chord of each truss, to act as a hinge until the arch has been swung free of the temporary supports. The arch design is based upon having this hinge at the crown of the arch. However, because of the necessity of keeping the navigation channel, which is close to the Port Richmond shore, free of falsework, unsymmetrical erection is necessary, and the temporary hinge will be at a point 248 feet south of the crown of the arch.

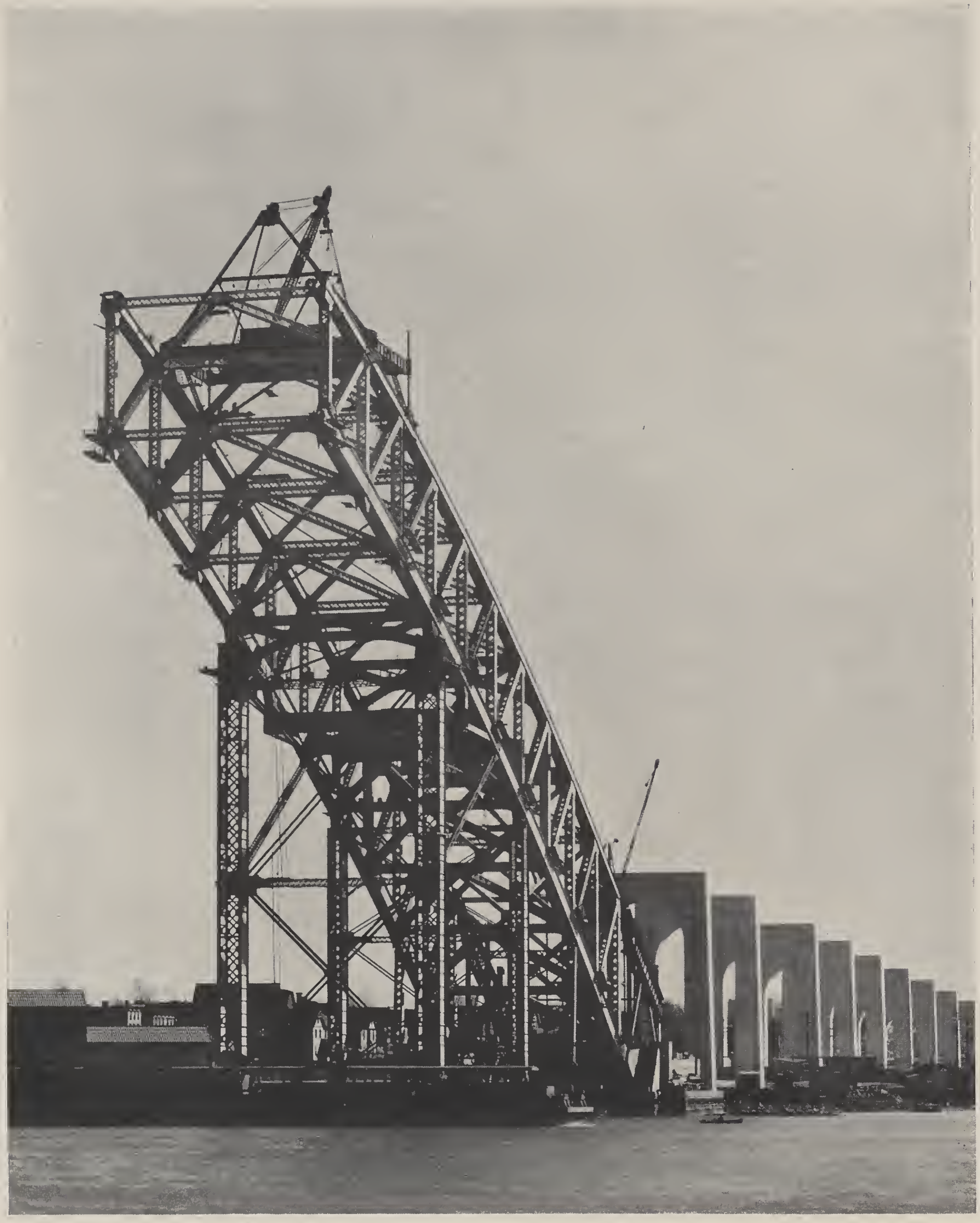
The arch is being erected by cantilevering from each side to the connecting point over the channel. Temporary steel piers or bents, made up largely of material which will be used later for the bridge deck and the approaches, support the arch trusses at certain points as the erection proceeds. Four such bents are used for the south arm and six for the north arm of the arch. Hydraulic jacks, installed on alternate bents, raise the arch from the preceding bent and then lower it to full bearing on the succeeding bent, as erection proceeds, each bent being wholly unloaded as soon as erection has advanced to the succeeding bent. The hydraulic jacks used by the contractor were manufactured for and originally used in the erection of the Hell Gate Bridge. Each jack has a capacity of more than 3,500 tons. The south arm of the arch was erected to the connecting point over the channel before erection of the north arm was commenced, and the falsework bents released from that arm are being used again to support the north arm.

A single erection traveler, which moves on rails along the upper chords of the trusses, is employed for the work. This traveler consists of a silicon steel frame supporting an erection derrick with 70 ft. boom and gasoline engines for operating the derrick. Upon completion of the erection of the south arm of the arch, this traveler was backed off to the abutment, and there dismantled and moved across the waterway to the north abutment, where it was again assembled for erection of the north arm.

After the north arm has been erected, and the hinge connection made to the south arm, the jacks at the remaining bent under each arm will be lowered to swing the arch free of the two bents. It will then be a three-hinged arch, with the third hinge at the fourteenth panel of the south arm. In order to establish the design condition of a hinge at the crown of the arch instead of at this fourteenth panel point, the jacks on the falsework bent beneath the south arm will be raised again to lift the arch a definite amount, which is calculated as the amount needed to remove all stress from the closing chord connection. In this position, the closing connection of the top chords between the two arms will be riveted in place, and the jacks will then be lowered to swing the arch free in its final two-hinged condition.

The approaches consist of a series of deck plate girder spans. The spans vary from 65 to 128 feet in length, and are simple spans, with the exception of one span 183 feet long which comprises the central portion of a three-span continuous girder.

Rolling of structural steel for the bridge was started in April, 1929, fabrication was started in May, 1929, erection was begun in September, 1929, and the erection of the



ARCH ERECTION, MARCH 14, 1930

south arm was completed in March, 1930. The arch span contains approximately 16,800 tons of steel, and the approaches contain 9,500 tons.

APPROACH PIERS

Construction of the approach piers was provided for in two contracts, awarded March 14, 1929. Thirteen proposals for the construction of the Bayonne Approach Piers, and nineteen proposals for the construction of the Port Richmond Approach Piers, were received, and the contracts were awarded respectively to P. T. Cox Contracting Co., Inc., and Arthur McMullen Company, the low bidders.

The approach piers are of reinforced concrete, varying in height from 20 to 110 feet above the surface of the ground. The lower piers consist, in general, of two independent hollow shafts. The higher piers consist of two hollow shafts connected at the top by an arch. The principal reinforcement is a structural steel frame, composed of angles with bolted connections, embedded in each pier. These structural frames furnished means for holding the forms in place as well as forming rigid reinforcement for the concrete. In addition to the frames, "surface reinforcement" by steel rods is used near the exterior surfaces.

Footings on rock were determined upon for the higher piers, and spread footings were adopted for the lower ones where the overburden was of solid character.

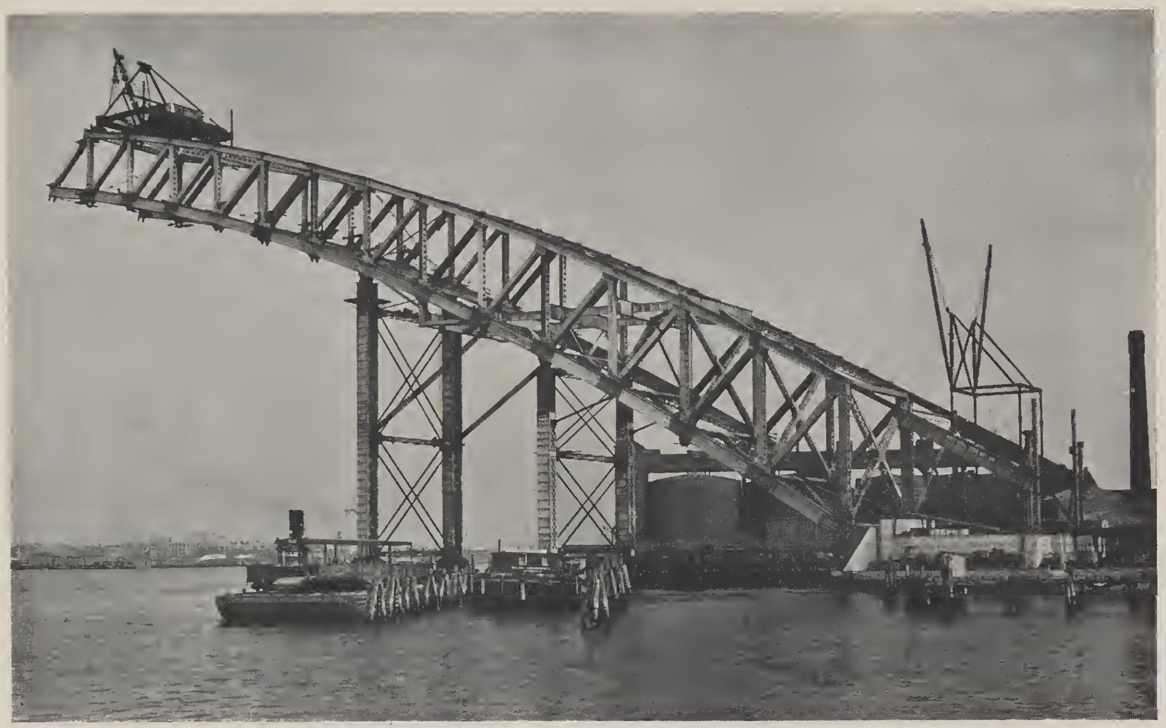
Excavation for the approach pier foundations was started in Port Richmond on March 30, 1929, and in Bayonne on April 2, 1929. The contract for the Port Richmond piers was substantially complete in October, 1929, and that for the Bayonne piers in January, 1930.

In order to provide plant flexibility necessary for access to the piers over the length of each approach, the contractors in each case used paving mixers for mixing the concrete. The aggregates were batched by weight at a central batching plant and delivered to the work ready for dumping into the mixer. Traveling cranes were used for handling excavation by clam-shell buckets, for disposal of excavated materials, and for handling forms and erecting structural steel. The cranes were used for placing concrete by bottom dump buckets in the lower piers. Chuting systems, with towers erected at convenient points along the approach, were used for concreting the higher piers.

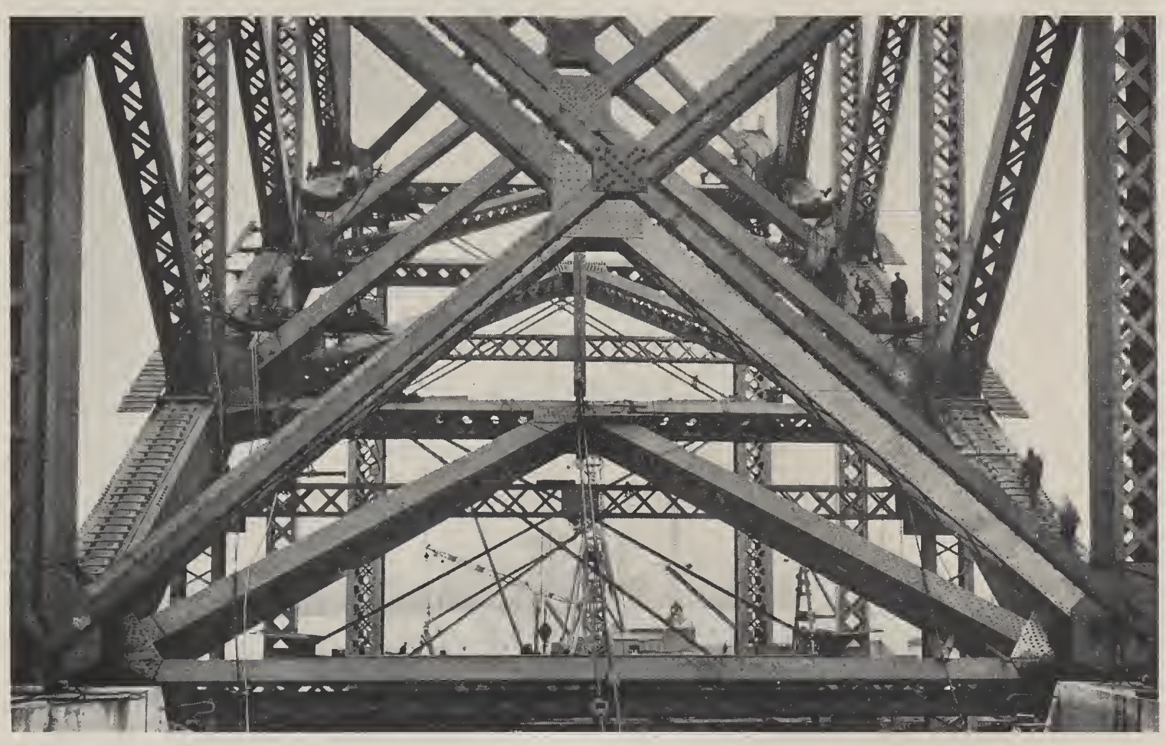
RESEARCH AND SPECIAL TESTS

TEST MODEL OF ARCH SPAN

On account of the great size of this bridge, and in order to check the theoretical stress investigations, it was considered advisable to construct a test model of the arch span and subject it to loading simulating that which will come upon the completed bridge.

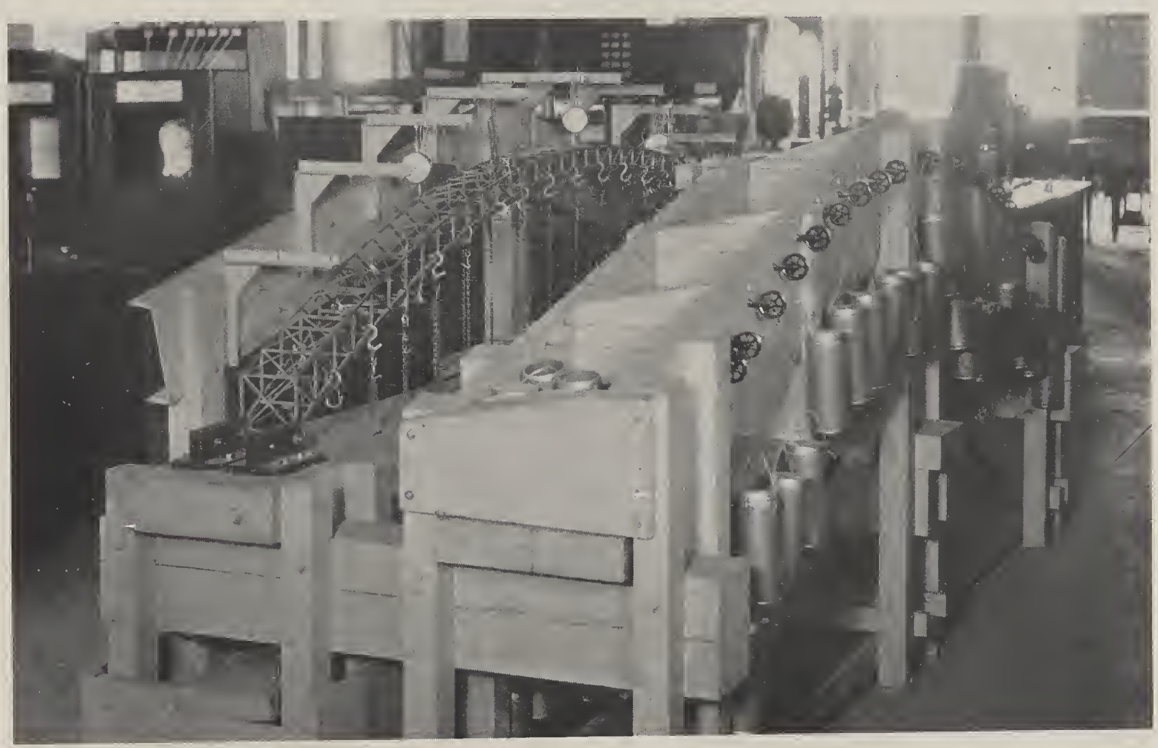


ARCH ERECTION—ERECTION OF SOUTH ARM COMPLETED—APRIL 1, 1930



ARCH ERECTION—VIEW FROM PORT RICHMOND ABUTMENT, SHOWING SWAY BRACING

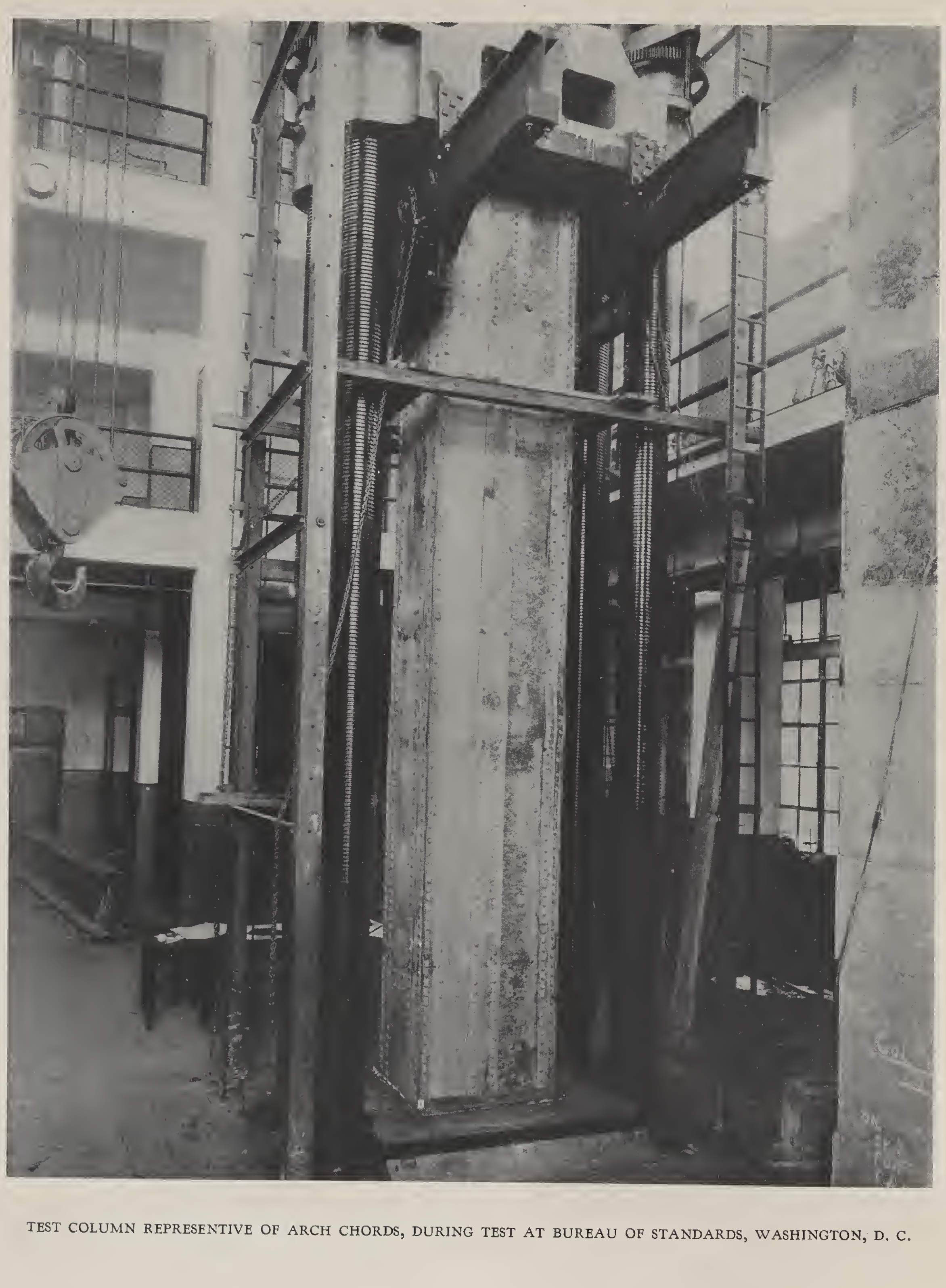
The model was constructed with all the arch members made of engravers' brass, a material of very uniform quality. It was built to a scale of 1–16 inch to a foot, making a convenient length of about 9 feet for the arch model. The arch trusses for the model were each cut in one piece from sheets of brass ¼ inch thick. The bracing members between the trusses were made of rods ⅛ inch square. Connections between the members were made principally with "silver" solder, although gusset plate connections fastened with soft solder were used for connections of the diagonal members between the trusses.



BRASS MODEL OF ARCH, USED FOR STRESS INVESTIGATIONS

The completed brass arch model was set on heavy steel shoes, the connections between the arch rib and each shoe being made with a turned steel bolt ½ inch in diameter, to represent the arch hinge. The shoes were mounted rigidly on a timber framework to which were secured two 8-inch steel channels to furnish a base for measurements.

The experimental tests made on this model consisted in the application of vertical and horizontal loads at the various panel points, and the observation by sensitive instruments of the deflections of the model and the strains in its members. A complete mathematical analysis for the arch model was also made and the observed deflections compared with those computed.



TEST COLUMN REPRESENTIVE OF ARCH CHORDS, DURING TEST AT BUREAU OF STANDARDS, WASHINGTON, D. C.

In order not to overload the building floor where the tests were made, the vertical loads were applied through a leverage system having a ratio of seven to one. Loads were applied at every second panel point through this lever system, in concentrations of 175 pounds.

The deflections were measured by dial indicators graduated to one thousandth of an inch and permitting reading to one ten-thousandth of an inch. Punch marks were made in the brass model and in the steel measuring base to furnish fixed points for the placing of the dial indicators. In addition to the deflection measurements, strain gauge measurements were made to determine the strains in certain members.

The observations on the model proved very satisfactory in checking the behavior of the arch under the conditions simulating those which will occur on the bridge. The model analysis is particularly valuable in determining the strains in certain members, such as the sway bracing between the trusses, for which the mathematical analysis becomes particularly involved and intricate.

SPECIAL COLUMN TESTS

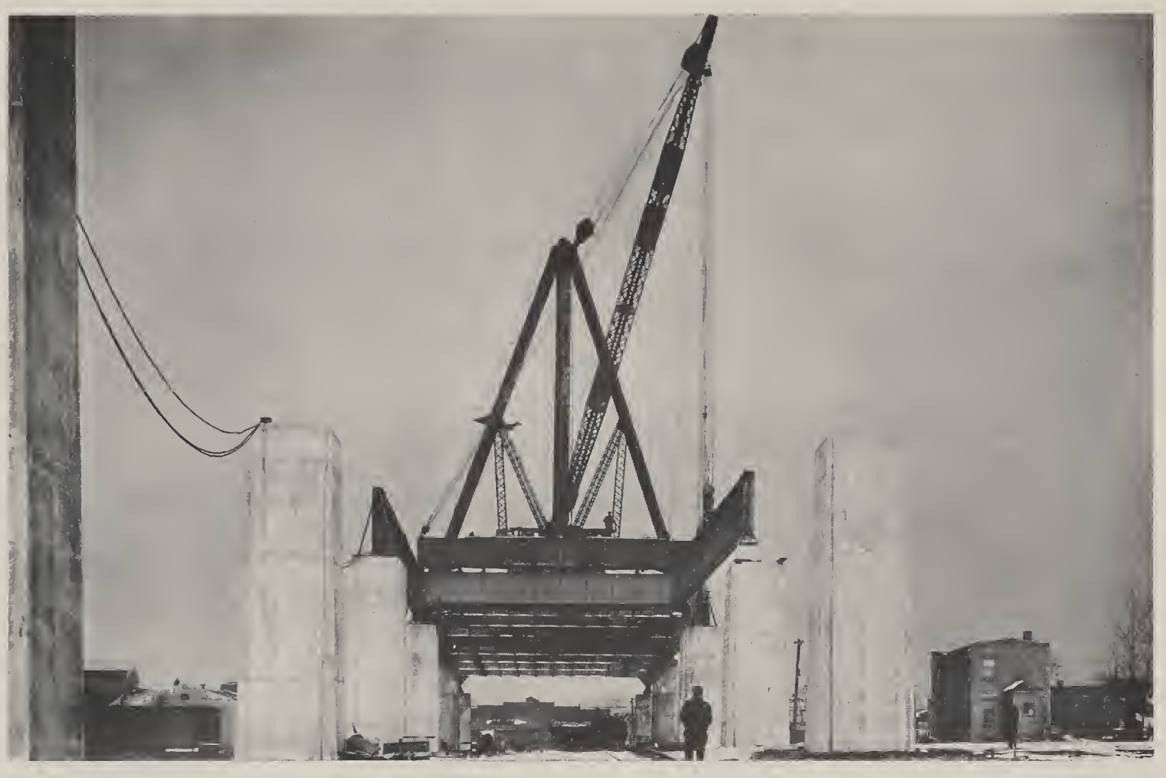
In order to supplement the mathematical stress analyses of the heavy built-up sections used in the arch chords, special tests have been made to determine the behavior of such members in compression under load up to the point of failure. These tests were made in conjunction with similar investigation of sections representative of the heavy columns of the Hudson River Bridge towers. The test columns comprised six specimens similar to the Hudson River Bridge tower columns and two specimens similar to the Kill van Kull arch chords.

The columns representative of the arch chords were of carbon-manganese steel, the material adopted for the chords, of which no large size column tests had been made before. They were of double box section, with solid walls and diaphragms, 20 ft. 9 in. in length, and with a sectional area of 155 sq. in. These dimensions of the test columns are one-half those of one of the smaller sections of the lower chord of the arch trusses.

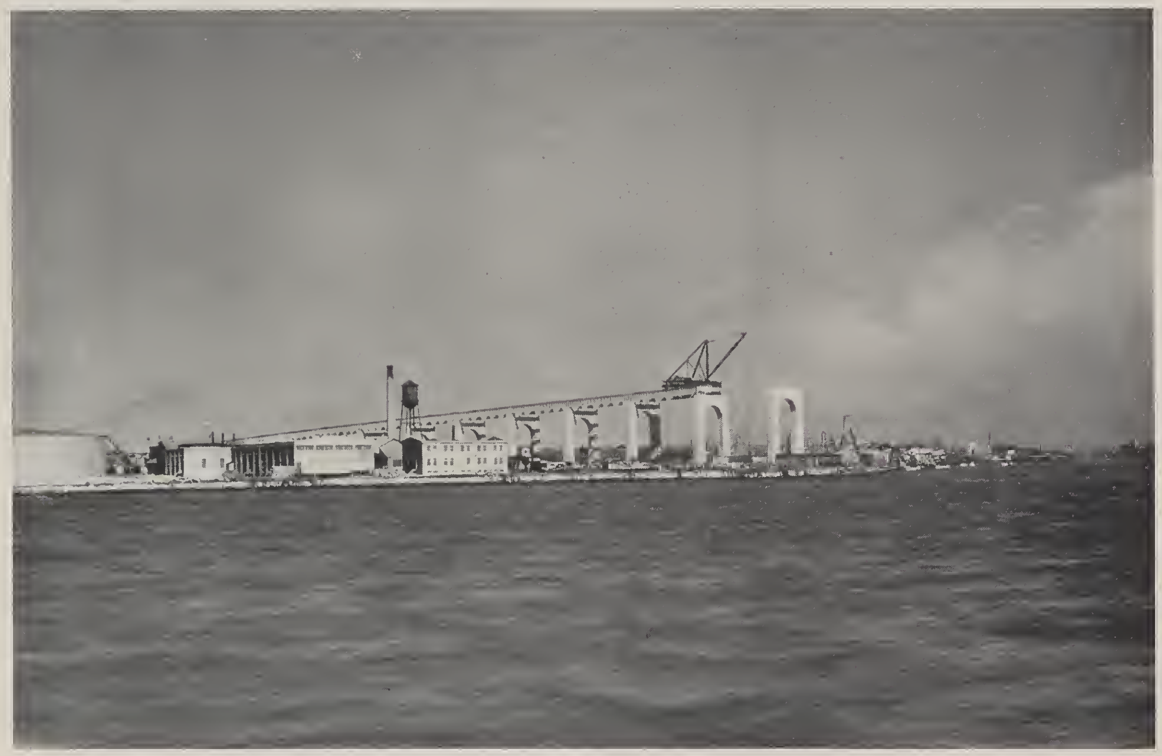
The tests were made in the compression machine of the U. S. Bureau of Standards in Washington, having a capacity of ten million pounds, and were conducted to determine the elastic behavior of the parts, as well as the deformation and strength of the entire column. The two Kill van Kull test columns failed under stresses of 59,000 and 58,650 lbs. per sq. in. respectively, representing efficiencies of 99.0 and 98.4 per cent. as compared to the yield point determined from routine specimen tests. Primary failure occurred by buckling of the cover plates, and, as a result of the data obtained from the tests, the chords were redesigned with thicker cover plates.

ACKNOWLEDGMENTS

On September 14, 1929, the Staff unfortunately suffered the loss, by death, of one of its most devoted members, Mr. William J. Boucher, who was Engineer of Construction



STEEL ERECTION, BAYONNE APPROACH, FEBRUARY 17, 1930



STEEL ERECTION, BAYONNE APPROACH, MARCH 21, 1930 for the Kill van Kull Bridge. Mr. Boucher had been associated with the Engineering Staff of the Port Authority since 1923 and had rendered particularly valuable service in the development of the plans for, and the direction of the construction of, The Outerbridge Crossing, The Goethals Bridge, and the Kill van Kull Bridge.

Acknowledgment is hereby made of the valuable advice and cooperation of various individuals and organizations in the elaboration of the plans and the execution of the work.

In the compilation of statistics regarding traffic over the ferries, the Public Service Corporation of New Jersey, the Brooklyn and Richmond Ferry Company, the Richmond Light and Railroad Company, and the Department of Plant and Structures of the City of New York, have given helpful cooperation to the Staff.

Lt. Colonel P. S. Bond, U. S. Engineer, Second New York District, aided construction of the bridge by granting permits for temporary piers in the Kill van Kull channel.

The operations of the contractor in the erection of the arch were greatly facilitated by the action of Captain Randolph Ridgely, Jr., U. S. Coast Guard, in granting permission to operate tugs and carfloats in the Kill van Kull channel.

The plan for the Bayonne Approach was developed in collaboration with Hon. G. E. Keenan, Commissioner, City of Bayonne; Hon. Joseph Minton, Commissioner, City of Bayonne; Mr. Walter L. Clarkson, City Engineer of Bayonne; Mr. T. J. Wasser, Supervising Engineer, Board of Chosen Freeholders, Hudson County; Mr. F. J. Radigan, County Engineer, Hudson County; Mr. Philip Guise, City Development Engineer of Jersey City; and Mr. Fred Lavis, later succeeded by Colonel H. W. Hudson, representing the New Jersey State Highway Commission.

The plans for the Port Richmond Approach were made in collaboration with Mr. Theodor S. Oxholm, Consulting Engineer to the Borough of Richmond, and Mr. Thomas B. Oakley, Engineer of the Borough of Richmond, and Mr. Arthur S. Tuttle, Consulting Engineer of the Board of Estimate and Apportionment of the City of New York.

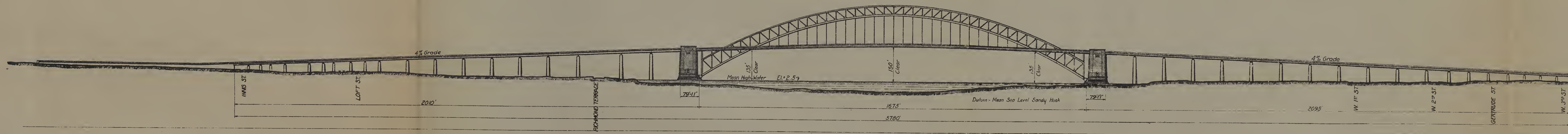
The cooperation of Mr. George K. Burgess, Director of the U. S. Bureau of Standards, and his staff, in connection with special tests, is gratefully acknowledged.

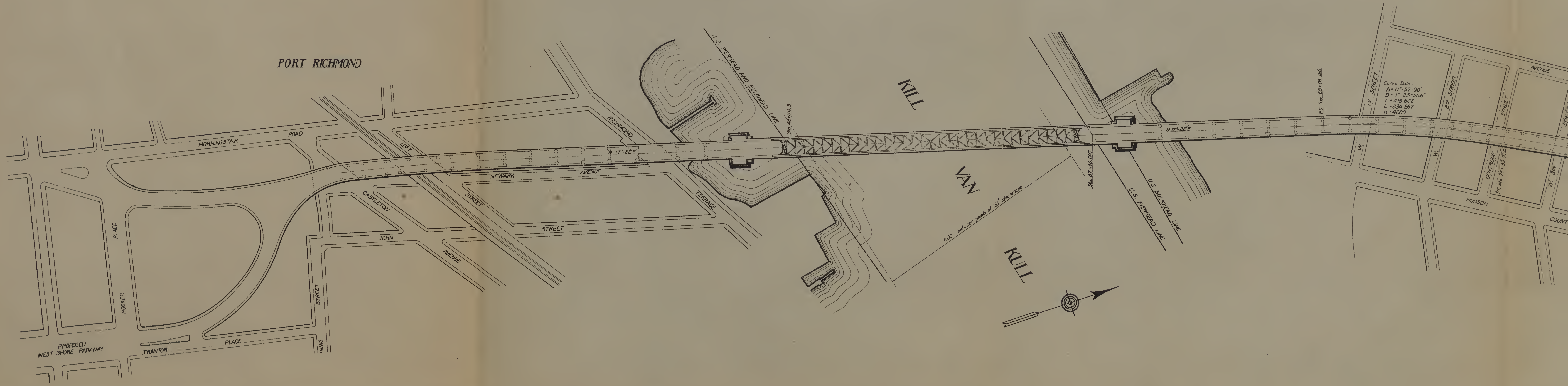
The contractors, named elsewhere herein, are to be given credit for their efforts in the performance of the construction work.

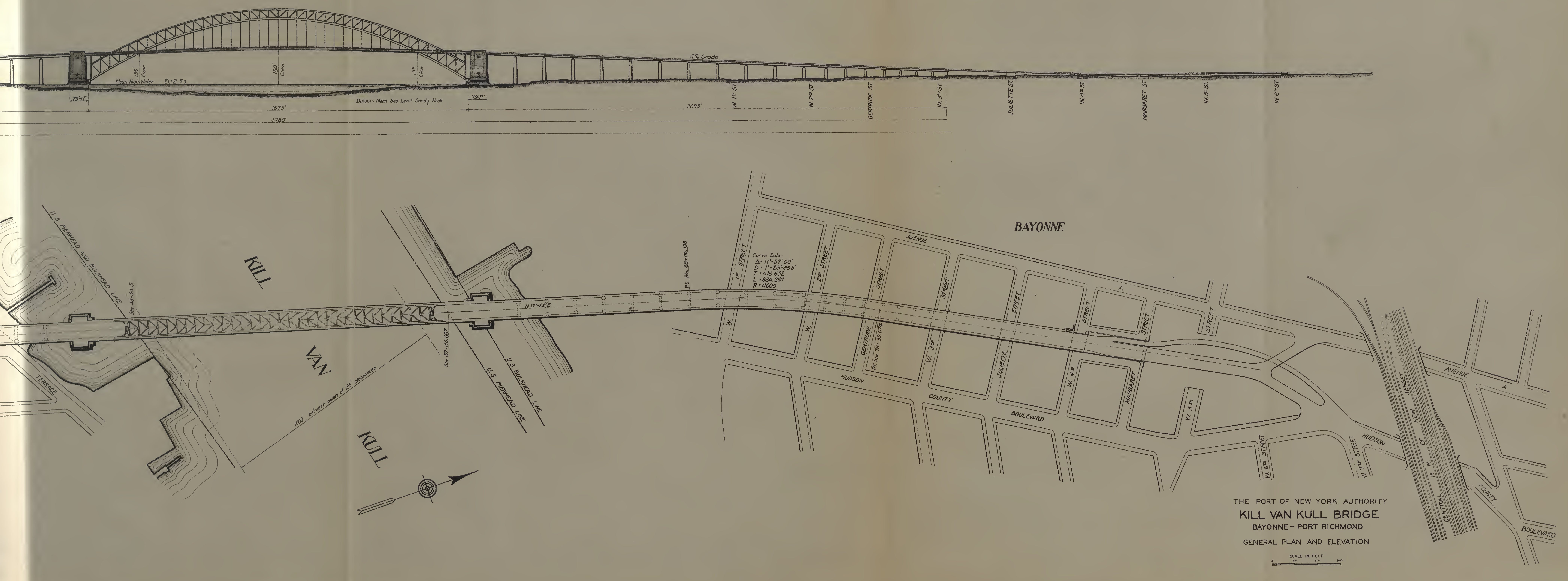
The undersigned takes this occasion to express his appreciation to the Architect and the Consulting Engineers for their valuable advice and to the other members of the Port Authority Staff for their cooperation and devotion to the work.

Respectfully submitted,

(Signed) O. H. Ammann,
Chief Engineer of Bridges.


4% Grade
INNIS ST.
LOFT ST.
RICHMOND TERRACE
2010'
79'-11"
135' Clear
150' Clear
135' Clear
Mean High Water El.+2.5
Datum:- Mean Sea Level Sandy Hook
1675'
79'-11"
5780'
4% Grade
2095'
W. 1st ST.
W. 2nd ST.
GERTRUDE ST.
W. 3rd ST.


PORT RICHMOND
MORNINGSTAR ROAD
LOFT STREET
RICHMOND TERRACE
NEWARK AVENUE
CASTLETON AVENUE
JOHN STREET
HOOKER PLACE
INNIS STREET
TRANTOR PLACE
PPOROSED WEST SHORE PARKWAY
N. 17°-22' E.
U.S. PIERHEAD AND BULKHEAD LINE
Sta. 43+54.5
KILL VAN KULL
1000' between points of 135' clearances
Sta. 57+40.687
U.S. PIERHEAD LINE
U.S. BULKHEAD LINE
N 17°-22' E
P.C. Sta. 68+06.196
Curve Data:-
Δ = 11°-57'-00"
D = 1°-25'-56.8"
T = 418.652
L = 834.267
R = 4000
W. 1st STREET
W. 2nd STREET
GERTRUDE STREET
P.T. Sta. 76+39.074
W. 3rd STREET
AVENUE
HUDSON
COUNT

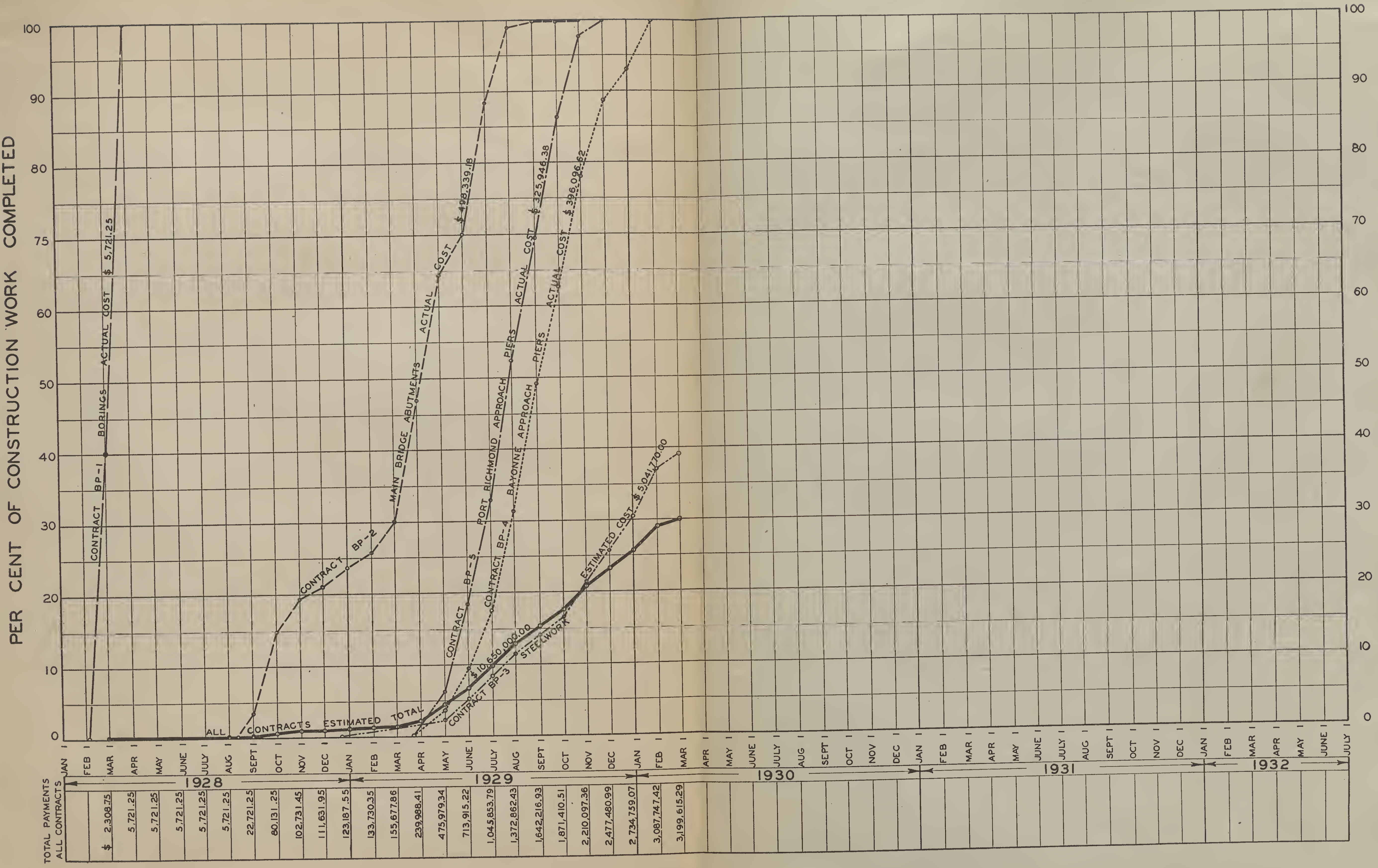


THE PORT OF NEW YORK AUTHORITY

KILL VAN KULL BRIDGE

BAYONNE – PORT RICHMOND

GENERAL PLAN AND ELEVATION



TOTAL PAYMENTS ALL CONTRACTS	
1928 MAR	$ 2,308.75
APR	5,721.25
MAY	5,721.25
JUNE	5,721.25
JULY	5,721.25
AUG	5,721.25
SEPT	22,721.25
OCT	80,131.25
NOV	102,731.45
DEC	111,631.95
1929 JAN	123,187.55
FEB	133,730.35
MAR	155,677.86
APR	239,988.41
MAY	475,979.34
JUNE	713,915.22
JULY	1,045,853.79
AUG	1,372,862.43
SEPT	1,642,216.93
OCT	1,871,410.51
NOV	2,210,097.36
DEC	2,477,480.99
1930 JAN	2,734,759.07
FEB	3,087,747.42
MAR	3,199,615.29

KILL VAN KULL BRIDGE

CONSTRUCTION PROGRESS
AS SHOWN BY
MONTHLY PAYMENTS ON CONTRACTS

TABULATION OF BIDS FOR MAIN BRIDGE ABUTMENTS

CONTRACT BP–2

Received July 5, 1928

		ITEM 1	ITEM 2		ITEM 3		ITEM 4		ITEM 5		ITEM 6		ITEM 7		ITEM 8		
		LUMP SUM	3,000 CU. YDS.		2,000 CU. YDS.		33,000 CU. YDS.		50,000 BBLS.		1,000 CU. YDS.		320,000 LBS.		90,000 LBS.		
	Bidder	COFFERDAMS IN PLACE	EXCAVATION, OTHER THAN ROCK, BELOW ELEV.–18.0 IN PORT RICHMOND ABUTMENT AND ELEV.–10.0 IN BAYONNE ABUTMENT		ROCK EXCAVATION, ABOVE ELEV.–30.0 IN PORT RICHMOND ABUTMENT AND ABOVE ELEV.–20.0 IN BAYONNE ABUTMENT		CONCRETE, IN PLACE		CEMENT, MIXED IN CONCRETE		GRANITE MASONRY		REINFORCING STEEL IN PLACE		STRUCTURAL STEEL IN PLACE		ESTIMATED TOTAL CONTRACT PRICE
		Amount	*Unit Price*	*Amount*	*Unit Price*	*Amount*	*Unit Price*	*Amount*	*Unit Price*	*Amount*	*Unit Price*	*Amount*	*Unit Price*	*Amount*	*Unit Price*	*Amount*	
1	H. P. Converse	127,249	1.12	3,360	6.13	12,260	4.82	159,060	2.38	119,000	74.21	74,210	.046	14,720	.065	5,850	515,709
2	Cornell Contracting Corp.	177,000	1.50	4,500	4.00	8,000	5.00	165,000	2.25	112,500	60.00	60,000	.04	12,800	.05	4,500	544,300
3	G. Dekimpe	100,000	1.00	3,000	5.00	10,000	5.00	165,000	3.00	150,000	114.00	114,000	.05	16,000	.10	9,000	567,000
4	Triest Contracting Corp.	174,000	5.00	15,000	10.00	20,000	4.00	132,000	2.50	125,000	90.00	90,000	.04	12,800	.06	5,400	574,200
5	The Tunnel Construction Corp.	181,000	1.00	3,000	8.00	16,000	4.50	148,500	2.40	120,000	89.00	89,000	.05	16,000	.06	5,400	578,900
6	Silas Mason Company, Inc.	180,000	3.00	9,000	7.00	14,000	5.50	181,500	2.25	112,500	73.50	73,500	.04	12,800	.06	5,400	588,700
7	Merritt-Chapman & Scott Corp.	147,200	3.50	10,500	6.80	13,600	6.70	221,100	2.25	112,500	70.00	70,000	.04	12,800	.07	6,300	594,000
8	Frederick Snare Corp.	200,000	2.00	6,000	10.00	20,000	6.00	198,000	2.25	112,500	70.00	70,000	.045	14,400	.08	7,200	628,100
9	Arthur McMullin Company	214,000	6.00	18,000	20.00	40,000	5.80	191,400	2.40	120,000	50.00	50,000	.04	12,800	.07	6,300	652,500
10	The Foundation Company	115,000	4.00	12,000	20.00	40,000	7.00	231,000	3.00	150,000	84.00	84,000	.06	19,200	.09	8,100	659,300
11	Necaro Company, Inc.	160,000	4.00	12,000	15.00	30.000	4.80	158,400	3.00	150,000	125.00	125,000	.06	19,200	.07	6,300	660,900
12	W. H. Gahagan, Inc.	210,000	10.00	30,000	10.00	20,000	5.60	184,800	2.60	130,000	80.00	80,000	.05	16,000	.07	6,300	677,100
13	Albert A. Volk Company, Inc.	200,000	10.00	30,000	15.00	30,000	6.00	198,000	3.00	150,000	100.00	100,000	.05	16,000	.10	9,000	733,000
14	Stillman-Delehanty-Ferris Co.	225,000	1.75	5,250	8.00	16,000	7.00	231,000	2.70	135,000	100.00	100,000	.064	20,480	.08	7,200	739,930
15	The Phoenix Construction Co.	359,700	4.00	12,000	11.00	22,000	4.30	141,900	2.73	136,500	81.00	81,000	.055	17,600	.08	7,200	777,900

TABULATION OF BIDS FOR STEELWORK

CONTRACT BP–3

Received November 19, 1928

Item	Description	Quantities for Comparison	American Bridge Co.		Bethlehem Steel Co.		McClintic-Marshall Co.	
			Unit Price	*Amount*	*Unit Price*	*Amount*	*Unit Price*	*Amount*
1	Carbon Steel in Arch Span, except in Items 7 to 10, incl.	16,200,000 lbs.	$.095	$1,539,000	$.111	$1,798,200	$.1115	$1,806,300
2	Silicon Steel in Arch Span	8,000,000 lbs.	.113	904,000	.1198	958,400	.1195	956,000
3	Nickel Steel in Arch Span	9,400,000 lbs.	.133	1,250,200	.1298	1,220,120	.1325	1,245,500
4	Carbon Steel in Approaches, except in Items 7, 8 and 10	9,200,000 lbs.	.0585	538,200	.0605	556,600	.0675	621,000
5	Silicon Steel in Approaches	8,300,000 lbs.	.07	581,000	.066	547,800	.0715	593,450
6	Nickel Steel in Approaches	700,000 lbs.	.087	60,900	.0785	54,950	.09	63,000
7	Forged Carbon Steel	790,000 lbs.	.133	105,070	.169	133,510	.155	122,450
8	Cast Steel	300,000 lbs.	.095	28,500	.1175	35,250	.1075	32,250
9	Railings on Arch Chords	110,000 lbs.	.23	25,300	.175	19,250	.20	22,000
10	Concrete, Reinforcement and Granite Facing, all in place	Not estimated		9,600		7,500		8,000
	Total Estimated Contract Price			$5,041,770		$5,331,580		$5,469,950

TABULATION OF BIDS FOR BAYONNE APPROACH PIERS

CONTRACT BP–4

Received March 4, 1929

	Bidder	Item 1 3,600 cu. yds. Excavation to twelve (12) Ft. below Ground Surface		Item 2 900 cu. yds. Excavation Beyond Twelve (12) Ft. below Ground Surface		Item 3 3,400 cu. yds. Concrete in all Footings		Item 4 11,600 cu. yds. Concrete in Piers above Footings		Item 5 21,000 bbls. Cement Mixed in Concrete in Permanent Structure		Item 6 650,000 lbs. Structural Steel in Place		Item 7 1,100,000 lbs. Reinforcing Steel in Place		Estimated Total Contract Price
		Unit Price	*Amount*	*Unit Price*	*Amount*	*Unit Price*	*Amount*	*Unit Price*	*Amount*	*Unit Price*	*Amount*	*Unit Price*	*Amount*	*Unit Price*	*Amount*	
1	P. T. Cox Contracting Co., Inc.	3.00	10,800	4.80	4,320	7.50	25,500	15.60	180,960	3.45	72,450	.06	39,000	.049	53,900	386,930
2	The Tunnel Construction Corp.	3.00	10,800	7.00	6,300	10.00	34,000	18.50	214,600	2.75	57,750	.06	39,000	.05	55,000	417,450
3	M. Millimet, Inc.	4.25	15,300	10.00	9,000	12.50	42,500	14.50	168,200	2.60	54,600	.07	45,500	.08	88,000	423,100
4	Remo Engineering Corp.	10.00	36,000	16.00	14,400	10.00	34,000	15.50	179,800	2.43	51,030	.07	45,500	.06	66,000	426,730
5	Arthur McMullen Co.	7.00	25,200	10.00	9,000	10.00	34,000	15.30	177,480	3.00	63,000	.08	52,000	.07	77,000	437,680
6	G. De Kimpe	5.00	18,000	6.00	5,400	10.00	34,000	18.00	208,800	2.87	60,270	.08	52,000	.055	60,500	438,970
7	Stange Construction Co.	5.00	18,000	10.00	9,000	12.00	40,800	20.00	232,000	2.50	52,500	.05	32,500	.05	55,000	439,800
8	Cornell Contracting Co.	9.00	32,400	13.00	11,700	9.00	30,600	20.00	232,000	3.00	63,000	.07	45,500	.04	44,000	459,200
9	Frederick Snare Corp.	6.50	23,400	8.50	7,650	12.50	42,500	20.00	232,000	2.80	58,800	.065	42,250	.048	52,800	459,400
10	H. P. Converse	12.73	45,828	16.70	15,030	15.72	53,448	19.94	231,304	2.20	46,200	.0712	46,280	.0498	54,780	492,870
11	Aronberg-Fried Co., Inc.	9.00	32,400	9.00	8,100	10.00	34,000	22.00	255,200	3.00	63,000	.07	45,500	.07	77,000	515,200
12	Triest Contracting Corp.	7.50	27,000	21.00	18,900	13.00	44,200	22.50	261,000	2.50	52,500	.08	52,000	.055	60,500	516,100
13	Louis Di Menna	12.00	43,200	12.00	10,800	24.00	81,600	24.00	278,400	2.50	52,500	.06	39,000	.06	66,000	571,500

TABULATION OF BIDS FOR PORT RICHMOND APPROACH PIERS

CONTRACT BP–5

Received March 4, 1929

	Bidder	ITEM 1 4,600 CU. YDS. EXCAVATION TO TWELVE (12) FT. BELOW GROUND SURFACE		ITEM 2 1,300 CU. YDS. EXCAVATION BEYOND TWELVE (12) FT. BELOW GROUND SURFACE		ITEM 3 3,500 CU. YDS. CONCRETE IN ALL FOOTINGS		ITEM 4 9,200 CU. YDS. CONCRETE IN PIERS ABOVE FOOTINGS		ITEM 5 18,000 BBLS. CEMENT MIXED IN CONCRETE IN PERMANENT STRUCTURE		ITEM 6 500,000 LBS. STRUCTURAL STEEL IN PLACE		ITEM 7 1,000,000 LBS. REINFORCING STEEL IN PLACE		ESTIMATED TOTAL CONTRACT PRICE
		Unit Price	*Amount*	*Unit Price*	*Amount*	*Unit Price*	*Amount*	*Unit Price*	*Amount*	*Unit Price*	*Amount*	*Unit Price*	*Amount*	*Unit Price*	*Amount*	
1	Arthur McMullen Co.	3.00	13,800	5.40	7,020	8.00	28,000	13.30	122,360	2.70	48,600	.07	35,000	.06	60,000	314,780
2	The Tuller Construction Co.	4.50	20,700	18.00	23,400	10.00	35,000	12.50	115,000	3.10	55,800	.06	30,000	.055	55,000	334,900
3	P. T. Cox Contracting Co., Inc.	3.30	15,180	3.40	4,420	7.50	26,250	16.00	147,200	3.45	62,100	.06	30,000	.054	54,000	339,150
4	Wilcox & Stutz, Inc.	3.25	14,950	20.00	26,000	8.50	29,750	14.00	128,800	3.50	63,000	.06	30,000	.06	60,000	352,500
5	The Tunnel Construction Corp.	2.50	11,500	7.00	9,100	10.00	35,000	18.20	167,440	2.75	49,500	.06	30,000	.05	50,000	352,540
6	Remo Engineering Corp.	8.00	36,800	13.00	16,900	10.50	36,750	15.50	142,600	2.50	45,000	.07	35,000	.06	60,000	373,050
7	G. De Kimpe	5.00	23,000	6.00	7,800	10.00	35,000	18.00	165,600	2.87	51,660	.08	40,000	.055	55,000	378,060
8	Frederick Snare Corp.	4.70	21,620	5.50	7,150	11.50	40,250	20.00	184,000	2.80	50,400	.065	32,500	.048	48,000	383,920
9	Stange Construction Co.	5.00	23,000	10.00	13,000	12.00	42,000	21.00	193,200	2.55	45,900	.05	25,000	.05	50,000	392,100
10	Cornell Contracting Corp.	5.75	26,450	10.00	13,000	9.00	31,500	21.00	193,200	3.00	54,000	.07	35,000	.04	40,000	393,150
11	Triest Contracting Corp.	6.50	29,900	20.00	26,000	12.50	43,750	22.00	202,400	2.50	45,000	.08	40,000	.055	55,000	442,050
12	Rice Contracting Co., Inc.	4.10	18,860	9.40	12,220	12.00	42,000	25.50	234,600	2.75	49,500	.065	32,500	.06	60,000	449,680
13	H. P. Converse	12.44	57,224	14.72	19,136	15.34	53,690	22.97	211,324	2.20	39,600	.0591	29,550	.051	51,000	461,524
14	Aronberg-Fried Co., Inc.	8.00	36,800	8.00	10,400	10.00	35,000	24.00	220,800	3.00	54,000	.07	35,000	.07	70,000	462,000
15	W. H. Gahagan, Inc.	5.00	23,000	7.00	9,100	15.30	53,550	26.00	239,200	2.57	46,260	.0675	33,750	.07	70,000	474,860
16	Albert A. Volk Co., Inc.	9.00	41,400	30.00	39,000	9.00	31,500	25.00	230,000	3.00	54,000	.09	45,000	.05	50,000	490,900
17	Roger H. Corbetta Concrete Co.	3.60	16,560	31.10	40,430	9.37	32,795	25.36	233,312	3.07	55,260	.093	46,500	.07	70,000	494,857
18	Louis Di Menna	12.00	55,200	12.00	15,600	24.00	84,000	24.00	220,800	2.50	45,000	.06	30,000	.06	60,000	510,600
19	The Tilt-Hargan Co.	18.05	83,030	20.00	26,000	16.75	58,625	22.80	209,760	2.50	45,000	.072	36,000	.097	97,000	555,415

M. B. Brown Printing & Binding Co.,
37-41 Chambers St., N. Y.